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Benefits of implementing standardized portfolio management practice in Estonian public sector ICT governance

Master's thesis

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Standardiseeritud portfellihalduse praktika rakendamise kasud Eesti avaliku sektori IKT valitsemises

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Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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Abstract

The governance of Information and Communication Technology (ICT) systems in the Estonian public sector faces persistent challenges, including fragmented management practices, overlapping roles, and inefficient resource allocation. These issues hinder the alignment of ICT operations with organizational goals and create disparities in service quality. This thesis addresses these problems by proposing a standardized portfolio management framework to unify processes, clarify roles, and harmonize ICT management with consumer domain portfolios.

Using a mixed-methods approach, including a CAWI survey with 48 respondents from 10 of Estonia's 11 ministry domains and a comprehensive literature review, the research identifies critical inefficiencies and provides actionable solutions. The proposed framework offers a pathway to improved resource optimization, workflow efficiency, and cross-silo collaboration, with the potential to mitigate ICT budgetary growth and support initiatives like life event services. While the findings demonstrate the value of standardization, their realization depends on effective implementation and cross-sector engagement. Future research should explore the impact of terminological differences in governance frameworks and their influence on organizational management and scalability of the proposed solutions.

Keywords: ICT Governance, Portfolio Management, Standardization, Public Sector ICT

This thesis is written in English and is 69 pages long, including 7 chapters, 9 figures and 4 tables.

Annotatsioon

Standardiseeritud portfellihalduse praktika rakendamise kasud Eesti avaliku sektori IKT valitsemises

Eesti avaliku sektori infosüsteemide haldus seisab silmitsi püsivate probleemidega, nagu killustatud juhtimispraktikad, kattuvad rollid ja ebaefektiivne ressurssi jaotus. Need probleemid takistavad IKT tegevusi paremini kooskõlastada avaliku sektori eesmärkidega ning põhjustavad ebaühtlast avalike teenuste kvaliteeti. Käesolev magistritöö käsitleb neid probleeme, pakkudes välja standardiseeritud portfellihaldusraamistiku, mis ühtlustab protsesse, loob selgust vastutustes ja rollides ja joondab IKT juhtimist avalike teenuste portfellidega.

Töö tugineb kombineeritud meetoditele, sealhulgas CAWI uuringule, milles osales 48 vastajat esindades 10-t Eesti 11-e ministeeriumi valitsemisalast, ning ulatuslikule kirjandusele. Uurimistöö toob välja kriitilised ebatõhusused ja pakub lahendusi, mis loovad võimalusi ressursside optimeerimiseks, töövoogude tõhustamiseks ja valdkondade vahelise koostöö parandamiseks. Samuti aitab standardiseeritud raamistik pidurdada IKT eelarve vajaduste kasvu ja toetada silode-üleseid algatusi, nagu sündmusteenused. Kuigi tulemused näitavad standardiseerimise väärtust, sõltub selle rakendamine tõhusast elluviimisest ja sektorite vahelisest koostööst. Tulevased uuringud peaksid uurima terminoloogilisi erisusi IKT valitsemise raamistikes ning nende mõju organisatsioonide juhtimisele ja pakutud lahenduste skaleeritavusele.

Võtmesõnad: IKT juhtimine, Portfellihaldus, Standardimine, Avaliku sektori IKT

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 69 leheküljel, 7 peatükki, 9 joonist, 4 tabelit.

List of abbreviations and terms

BABOK	Business Analysis Body of Knowledge – A globally recognized standard for business analysis practices.
BI	Business Intelligence – Technologies and strategies used for data analysis in organizations.
BIZBOK	Business Architecture Body of Knowledge – A framework for business architecture practices.
BPM	Business Process Management – A methodology to improve business processes systematically.
CAWI	Computer-Assisted Web Interviewing – A web-based survey data collection method.
CD/CI	Continuous Delivery/Continuous Integration – Practices for automating software development and deployment.
CGIAR	Consultative Group on International Agricultural Research – Global research partnership for food security (if relevant to thesis context).
CIO	Chief Information Officer – The senior executive responsible for IT strategy and management.
COBIT	Control Objectives for Information and Related Technologies – A framework for IT governance and management.
e-ID	Electronic Identification – Digital identity used for authentication and verification.
EU	European Union – A political and economic union of European countries.
GDPR	General Data Protection Regulation – EU regulation for data privacy and protection.
HR	Human Resources – The function managing personnel and organizational workforce.
ICT	Information and Communication Technology – Technology used for managing and processing information.
ID	Identification – Systems or processes for identifying individuals or entities.
IS	Information Systems – Systems used to collect, process, and store data.
ISACA	Information Systems Audit and Control Association – A global association for IT governance and audit professionals.

ISO	International Organization for Standardization – A body setting global standards across industries.
ISO/IEC	Joint standards by ISO and International Electrotechnical Commission for IT and electronics.
IT	Information Technology – Use of systems for managing and processing information.
ITIL	IT Infrastructure Library – A framework for IT service management best practices.
MEAC	Ministry of Economic Affairs and Communications (Estonia) – Oversees ICT policy and governance.
OM	Operations Management – Practices ensuring efficient business operations.
OO	Object-Oriented – A programming paradigm based on objects and data structures.
OP	Operational Processes – Key processes within organizations.
PD	Product Development – The process of designing and improving products.
PMI	Project Management Institute – Organization providing standards for project management.
PRIA	Agricultural Registers and Information Board (Estonia) – Manages agricultural data systems.
PS	Public Sector – The government-operated sector of the economy.
RIA	Information System Authority (Estonia) – Manages national information systems and cybersecurity.
RIK	Centre of Registers and Information Systems (Estonia) – Develops state registries and IT systems.
RIT	Estonian IT Centre (Estonia) – Systems supporting research data management.
RMIT	IT Centre for Ministry of Finance (Estonia) – ICT management silo under the Ministry of Finance.
SLA	Service Level Agreement – A contract defining the expected level of service.
SMIT	IT and Development Centre of the Ministry of the Interior (Estonia) – Responsible for public safety IT systems.
SVS	Service Value System – Framework describing service delivery components (e.g., in ITIL).
TEHIK	Health and Welfare Information Systems Centre (Estonia) – Develops digital health solutions.

TOGAF	The Open Group Architecture Framework – A methodology for enterprise architecture development.
X-Road	Secure data exchange layer for digital services in Estonia – Ensures interoperability of public systems.

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1 Introduction

1.1 AS-IS of Estonian ICT management

ICT governance plays a vital role in modern public administration, providing the frameworks, processes, and oversight needed to align technology investments with the strategic goals of government institutions. For a country like Estonia, renowned for its pioneering efforts in e-Governance, ICT governance is not just an operational necessity but a critical enabler of its global leadership in digital transformation. Following is a short overview of the AS-IS situation in Estonian public sector ICT management.

1.1.1 Estonian ICT management silos

Estonian government ICT management silos have formed and developed over the past 20 years in each government silo independently. Consolidation first started by consolidating ICT competences from business units to separate IT departments within government organizations. From there on, consolidation continued across government organizations moving up the governance hierarchy. By consolidating IT service resources (human, technology) above sub-organizations on the ministry level, ministries ICT-competence centers were formed to serve the ICT needs of their respective ministries and sub-agencies. In some ministries a separate ministry sub-agency was created, where ICT competences of that ministry domain were consolidated. Stand-alone organizations like IT and Development Centre of the Ministry of the Interior of Estonia (abbreviated as "SMIT" from agency's Estonian name) or The Information Technology Centre of the Ministry of the Environment of Estonia (abbreviated as "KeMIT" from agency's Estonian name) are examples of consolidation outcomes. These stand-alone organizations are also called as Estonian IT-houses.

But not all ministries formed a stand-alone organization to that effect. Some ministries added the IT-department into their ministry's organization structure and consolidated the necessary competences into that unit without forming a separate organization apart from the ministry. In 2024, out of eleven ministries of Estonia. There are five ministries, who

have their own dedicated IT-houses (SMIT, RMIT, KeMIT, TEHIK, RIK) and six ministries, who have consolidated their ICT competencies under ministry's organizational unit or divided it between different organizational units. For an example, under the Ministry of Regional Affairs and Agriculture, there are two main ICT competence centers - ministry's IT-department and ministry's sub-agency called Agricultural Registers and Information Board (abbreviated as "PRIA" from agency's Estonian name), which currently share the ICT management responsibilities within that ministry's domain.

Additionally, next to these competence centers, in 2021, the Estonian IT Centre (abbreviated as "RIT" from agency's Estonian name) was established to provide essential base ICT services (computer workstation, server infrastructure and related additional services) to public institutions. The aim was to consolidate related competencies and resources out of current competence centers for services standardization to address issues with labor, skills and the uneven quality of services and products. In 2024, the consolidation process is still ongoing.

There is another separate sub-agency under the Ministry of Economic Affairs and Communications (MEAC) called Information Authority (abbreviated as "RIA" from agency's Estonian name), who is a national competence center that shapes and secures the foundations of Estonia's digital society. This authority is responsible for managing and maintaining underlying central components of Estonian digital solutions, which are used by most Estonian public sector digital solutions (components like electronic ID, X-Road secure data exchange platform, data consent service, document exchange service, and others). But it is also responsible for providing Estonian cyber-defence, handling cyber incidents and providing personal state services to citizens and businesses (state portal Eesti.ee, proactive services, Bürokratt).

Across-silo collaboration in ICT management has been coordinated and managed mainly by State Information Technology Development Department in MEAC. As of 2024, this assignment has been passed on to Ministry of Justice.

These described agencies and organizational units make up Estonian public sector ICT management organization as a whole and are responsible for public sector digital solutions development and secure delivery. There is much talk in society about the idea

of consolidating these fragmented ICT management silos even further. The first step towards this was the creation of RIT as it consolidated horizontally infrastructure and workstation management functions out of the ICT management silos into centralized silo. There is pressure also from the private sector, where biggest development partners in Estonia are arguing that ICT management silos are inflating, which brings negative impacts to economy and further consolidation is needed [1].

1.1.2 Responsibilities of ICT management silos

ICT management silo responsibilities stem from global and local level, where global responsibilities represent the obligations to all public services provisioning – for an example data privacy obligation from GDPR [2], or data protection obligation from Estonian Law of Cyber-Security [3], Law of the Administrative Procedure [4]– and apply to each ICT management silo inherently directly or through localized regulations. Local obligations represent more of the direct needs of each public service domain ICT management and its specifics – in example from organizations or managed object's statutes or specific public service standard.

There are separate individual statutes for some managed objects, more specifically information systems or databases, which contain some specified collection of states data. These statutes usually include ICT management responsibilities for the specific managed object and go into more detail of what kind of states data this particular managed object is containing and what are the business rules and activities for managing this data.

These information systems or databases statutes also assign the roles of "Data Controller", "Joint Controller" and "Data Processor" (roles defined in the practices of EU data protection and privacy [5]) to certain parties. When "Data Controller" and "Joint Controller" roles usually belong to the business side of the organization then "Data Processor" is seen mostly as a separate organizational unit in relation to "Data Processor", who is processing personal data on behalf of "Data Controller" [6]. This is the role that is usually assigned to ICT competence centers. The definition of "Data Processor" overall responsibilities are said to be *"…to act only in accordance with the instructions of Data Controller…*." But in some cases, the ICT competence center itself can be "Data Controller" and then their responsibilities are also to *"…determine the purposes and means of processing personal data…*." These are very generic specifications in terms of

defining ICT management responsibilities, thus they can be treated only as a part of overall outlines for defining ICT management responsibilities framework.

The actual framework of responsibilities of each ICT management silo are stated in each organization's statute. The responsibilities listed within the statutes are more detailed for IT-houses but remain more generic for departmental ICT management silos.

For IT-houses, statute usually states the "Field of Activity" and "Tasks" for that organization. While "Field of activity" statement is generalization of all the responsibilities of organization, then "Tasks" give more detailed insight to each responsibility. The number of "Tasks" listed varies for each IT-house, as well as the wording to describe the extent of the tasks, even if their objective feels similar. For an example, in 2024 SMIT statute [7] lists 15 tasks, KeMIT statute [8] lists 14 tasks and TEHIK statute [9] lists 30 tasks. Usually "*…and other tasks required…*" type of task is the last one on the list, to cover everything else and leave the door open for unforeseen tasks or tasks unmentioned. Some statutes also extend their output out of their silo, stating that their task is also to service other governmental silos other than their own ministry. This is the case for an example with Ministry of Finance Information Technology Center ("RMIT"), who in addition to their own ministry's domain is also providing ICT management to the Ministry of Culture domain. But also with SMIT, who even states that not only can they service other government institutions, but they have the right to charge for these services.

For departmental ICT management silos, the statute is often limited to a "Field of Activity" level only, to give understanding of some sense of the responsibilities the departmental unit should have. This can include a short listing of management objects, task, and domains, but can also be more laconic. For an example in Ministry of Culture, ICT-related responsibilities can be found under the Department of Strategy and Innovation, for which the ministry's statute lists ICT-related responsibilities amongst other business domain-related responsibilities as shortly as *"…coordinate information technology domain, including information security, management and development …*" [10], and nothing else.

Of course, the details of the responsibilities go more in detail for each organization unit in organization's statutes and are further expanded in each employees' positions job

description, but they always align with the responsibilities in organization statute. So, the statutes should always be comprehensive and universal.

But the wording of the responsibilities and their extent in statutes are different for all the ICT competence centers. Every statute tries to scope responsibilities by listing managed objects and management activities around them but does it differently than others.

1.1.3 Definition of managed objects

When one looks at ICT competence center statutes to find and understand what the managed objects within those silos are, where responsibilities have been assigned, then a colorful world of managed objects can be found. For instance, SMIT statute [7] includes managed objects like “ICT-solutions”, “ICT-systems”, “ICT-assets”, “ICT-services”, “datasets”, “data-models”, “data-capture-models”. KeMIT [8] statute includes managed objects like “IT-services”, “IT-architecture”, “Information Systems”, “IT-solutions”, “ICT-tools” (limiting it further to “software“, “hardware”, “communications and IT-related activities”). RMIT statute includes [11] “IT-services”, “hardware”, “software”, “datasets”, “ICT-services”, “ICT-tools”, “ICT-capacities”. These managed objects are considered to be the outputs or parts of the outputs of these ICT management silos.

Although these sets of managed objects differ, some similarities can be seen in the used terminology in the managed objects described. Since there are no definitions for the named managed objects in statutes itself then used terminology is left open for semantic interpretation for the reader. Since different ICT governance and management frameworks also treat the concepts of the same terminology differently, then one cannot be sure which definition was actually meant for managed object description in the statutes. Thus, it can be concluded that without providing the exact definitions for the managed objects, ICT management silo outputs described in the statutes are somewhat vague and ambiguous.

The outputs of Estonian ICT management silos are mostly defined as services, systems, or technology products. In the year of 2014, a public service portfolio management approach was proposed for Estonia in a MEAC ordered study [12]. This led to unified portfolio management practices adoption in public service management and the creation of public service catalogue and description standards. The idea was furthermore instilled with the adoption of activity-based-costing model for budgeting and planning in the

government organizations [13], where the target managed object for costing and budgeting was public service. That meant, that the output of each organization should also be a set of public services, where all the associated costs would be aggregated so that they could be further aligned with government higher strategic planning and management layers.

But not every government organizations output could be defined as public service itself, especially organizations with supportive functions towards public services – like consolidated accounting, consolidated HR, but also consolidated ICT – their function was to support public services inside their own management silo or across silos, but they couldn't be defined as public services themselves. Because by the definition of the public service, its output should provide value to the citizens or public community. So, government decided to expand the definitions for public services, and different types for public services more specific systematization was provided [14] - direct PS, indirect PS, and support services to the public services, which could be internal or external depending if outputs of these services were used by the same organization or other organizations as well. Now all organizations outputs could be described as all these types of services, and the costs could be aggregated on the service level.

In ICT management silos, this meant that collection of managed objects representing organization outputs were formed and all the outputs were called "services" despite the actual substance of the managed object or its provided output. The output could have been software product including its maintenance and management activities, or it could be just a software provision without those activities, it could have been some activity like "development" or "installing" without actual tangible elements, or provisioning of some piece of special hardware. This situation was well revealed in 2018 analysis ordered by Ministry of Interior [15] to analyse its ICT management silo (SMIT) service portfolio to prognose the budgetary needs for its services for next 10 years.

Since there were no guidelines for ICT competence centres, how to systematically approach to dividing their management objects into conforming sets and manage their associations, then each silo found their own way how to translate their managed objects under the terminological umbrella of "service", resulting in different and incomparable sets of managed objects within and across silos.

The arbitrariness of definitions of these “services” as managed objects and lack of uniform alignment to actual managed objects within ICT management silos, have resulted in discarding of those definitions in day-to-day management activities and has resulted in parallel accounting just so that ICT competence centres could still manage their objects to provide their output, but also fill their lawful obligations and agreements towards state budgeting, at least on the paper. This was also a finding in 2023 state audit [16], where National Audit Office of Estonia pointed out that activity-based budgeting enforcement has been failing, because ministries have taken the attitude, that this is something that is needed only for the sake of Ministry of Finance, and they don’t understand the goals or feel the benefits of it themselves. And that is the reason why it is not consistent with how things are actually being managed in real life.

It can be concluded that ICT management silo outputs or its associated managed objects are not well-defined, or their terminology well used within the current ICT management silo regulations in the clear manner, which would allow unambiguous understanding of those objects, relationships between those objects or ensure their comparability even within same object collection or across different collections (across silos).

1.1.4 Definitions of management tasks

While comparing management tasks across statutes, then it is seen that they include several different activities around the managed objects. Activities like “budgeting”, “planning”, “developing”, “managing”, “maintaining”, “organizing”, “coordinating”, “provisioning”, “procuring”, “training”, “supporting”, “delivering”, “tracking”, “monitoring”, “processing”, “giving input”, “making suggestions”, “cooperating”, “participating”, “enforcing”, and others are combined with different managed objects to limit the extent of the responsibilities current ICT management silo is fulfilling.

Activities listed do not provide clear understanding of what kind of activities in the list are generalization for a subset of activities, and which individually listed activities are included in the generalized subset. For an example if activity “managing a managed object” can be seen as collection of different activities, which would include usually “planning”, “budgeting”, “monitoring” and probably many other activities, then it is unclear, why for some managed objects explicitly only “planning” or “budgeting” activities are listed as responsibilities. This leaves room for questions and different interpretations. - Are they not members of “managing” activity? And if they are, why are

they used explicitly? Does that mean that other management activities are not included in the responsibilities for that managed object? What kind of other activities "managing" includes, that are not included in the responsibilities? – This leaves the reader of that statute guessing and actually gives a vague understanding of the extent of the actual responsibilities.

As seen from the statutes, activities for what ICT competence centers are responsible, are never exactly the same across silos, even in the cases where managed objects seem to be the same. Statute activity listings seem rather arbitrary and random. There seems to be no systematic approach to listing the activities across the silos, no standardized framework followed, much is left for the interpretation, thus no actual overview of the extent of management activities coverage or clarity of responsibilities. One is just left to believe that everything necessary for managing these objects is actually covered by the capabilities in these ICT management silos.

It can be concluded that management tasks defining the extent of the responsibilities of managed objects for ICT management silos, are not standardized. There is no unified approach to defining or semantically interpreting management tasks or their collections in the regulations. Across management silos, tasks lack comparability due to the nature of managed objects they are associated with or comparability lacks for tasks semantical generalization level. Thus, the full extent of required management tasks for managed objects and the assignment of responsibilities for fulfilling those tasks, are left unknown.

1.1.5 The impact of continuous change

Each ICT management silo has been governing mostly themselves autonomously and worked out the management practices for their operations on their own. When each new body was formed, the experiences of existing competence centers were considered to some extent, also universal practices and standards (like ITIL [17] or COBIT [18]), but mostly new customized management practices were formed based on the best understanding, expertise and personal experience of the leaders facilitating the formation of new bodies. There was no incentive or pressure to follow a certain standardized approach – every formed body could choose on their own how they would provide the output the business needed. This resulted in different customization of management practices across silos and sometimes even different for managed objects within the same silo. Different definitions for managed objects and approaches to managing them,

different level of generalization – some more general and some more detailed - different activities and responsibilities while providing services, different SLA-s with service customers.

Because of the fact that our environment is constantly changing, all ICT management silos have had to adapt to those changes as well deepening their differences in management practices even further and creating a greater level of customization around managed objects. Changes in ICT management silos leadership or policies, adapting to new principles or technological standards, changes in resource availability – all those changes put pressure for changes in ICT management as well. Redefining management objects, division of roles and responsibilities, redefining service management processes, fighting with technical debt, reconfiguring resource pools and acquiring or developing new tools and systems to support the changes has been constantly required.

But the biggest pressure for change comes from the business side. For Estonian ICT management silos, the business side is Estonian public services and their management. ICT managed objects and the output of ICT management silos – have to continuously support public services and their processes. Thus, any changes within business – in public services operations, organizations, processes, policies or regulations, roles and responsibilities, capacities and capabilities or anything directly or remotely associated could possibly mean that business needs for ICT management silo outputs change as well. The need for larger quantities of managed objects (more services, systems, data, resources) means more changes to manage for ICT management silos, which would need more and more resources to service. Growing need for ICT integration and process automatization on the business side, and the constant changes in public sector, which creates continuous need for change in associated ICT managed objects (services, equipment, information systems, registries, datasets, people etc.) has been the reason for growth in need of resources in ICT management silos over time.

Continuous change means there is continuous need to process change requests for managed objects. Every change request usually starts a series of activities like collecting the information about the change, understanding the scope and evaluating the impact, prioritizing, approving, or rejecting the change. Since processing ICT change requests means involving stakeholders from all impact areas, then it becomes imperative that all

the necessary and responsible parties associated with that change be identified and included.

But before this can happen, managed objects that are associated with the planned changes should be identified. In this procedure relationships between managed objects have to be considered. A change in one managed object could mean that there is a need for change in the associated managed object as well. For example, a planned change in public service procedure, could mean also a need for change in other managed objects associated with that object – a change in some core process in this public service value chain, or change in information system supporting processes, or change in number of people working in this service. These changes all have to be identified quickly and comprehensively so that the change implementation can succeed. If any area is left unidentified, there will be a higher risk for the change implementation to fail, making the change process more costly and time-consuming.

When managed objects are identified, then responsible parties for that managed objects can be identified as well. And when all the necessary parties are included, then the impact evaluation can start. Parties can now assess what has to be changed and what kind of resources would the change implementation need. And this gives the overall picture for the change impact. And then the priority of the change can be decided within the responsibility areas of each managed object and the overall change implementation timeline can be put in place.

Without the overview of the existing managed objects, associations between them and clearly defined responsibilities for managing these objects, the change request management within public sector and its supporting ICT management can take up long time and abundance of resources and also increase the risks for change implementation failure. Increasing volumes of managed objects and change requests put increasing pressure on organizational resources, increasing the need for optimization and standardization in their management activities to identify and eliminate waste. In the context of a limited state budget, this should be a priority.

1.1.6 Summary

Greater need for technological innovation in public sector business processes and need for stronger cooperation in cross-silo public services has put pressure to increase ICT

competence centers service capabilities to be able to service growing volumes of workstations, data centers, information systems, data registries and innovation projects.

Growing organizational size and administrative intensity are two main factors for influencing organization top management to decide abandoning customized production and adopt standardization within organization to maintain qualitative control over managed services [19]. As Estonian demand for public sector ICT capabilities is growing, it would be reasonable to look into standardization across Estonian ICT management silos to better over-come possible quality issues raising from the growth and expansion of service volumes.

Although ICT provides flexibility to public services provision, being an enabler to business processes it supports, it also becomes the controller of the same flexibility, putting standardized expectations and limitations to business [20]. Since ICT managed objects are being managed in cooperation between ICT management and business management, then the need for standardization in ICT management would also mean the need for standardization in business management.

In summarization, there is a growing need to discard the customized approaches and standardize in Estonian ICT management due to growing volumes of ICT management objects, and pressure their management puts to the existing resources together with state budgetary deficit.

1.2 Problem statement

Estonia’s public sector ICT management is constrained by inconsistent terminology, fragmented portfolio management practices for managing managed objects, and poorly defined responsibilities across silos. These issues undermine efficiency, interoperability, and the ability to scale and sustain ICT capabilities amidst growing demands for public service innovation and digital transformation.

This research addresses the need for a standardized framework to unify ICT management across silos, ensuring clarity, alignment, and operational effectiveness.

1.3 Research objectives

In response to previously described challenges, this research aims to research differences in current ICT management silo practices further and propose a standardized framework for supranational ICT management in Estonia's public sector to address the growing complexities and inefficiencies of siloed operations. Thesis objectives are following:

1. To research the differences in ICT management practices across Estonian ICT management silos.
2. Propose standardized framework for ICT management in Estonia's public sector to address the growing complexities and inefficiencies of siloed operations. Framework would include:

    - Standardized terminology for managed objects in ICT management silos.
    - Model for interpretation of standardized managed object collections and interrelations between the objects.
    - Roles and responsibilities framework for managing standardized ICT managed objects.

With this approach, author seeks to improve clarity, efficiency, and collaboration within and across ICT management silos, ensuring that Estonia's ICT capabilities are prepared to meet the growing demands of public service digitalization and innovation.

1.4 Research questions

Following are the research questions current research aims to answer:

- **RQ1:** What are the current differences in ICT management practices across Estonian ICT management silos, and what are their impacts? This question focuses on diagnosing the current state, identifying disparities and exploring their practical implications.
- **RQ2:** What standardized framework can be proposed for terminology, managed objects and their relationships, and roles and responsibilities? This question focuses on addressing standardization of ICT management framework in terminology, managed objects and their responsibilities.

- **RQ3:** What are the potential benefits of implementing a proposed standardized framework for ICT management? This question focuses on exploring the value and advantages of the proposed framework.
- **RQ4:** How can the proposed standardized framework be effectively implemented in Estonia's ICT management silos? This question focuses on developing an implementation plan for the proposed framework and addresses how the solution can be practically implemented in the current organizational and operational context.

1.5 Significance

This research is highly significant for Estonia as it addresses critical inefficiencies in ICT management practices across public sector silos, which undermine the scalability, interoperability, and efficiency of digital solutions. Estonia's reputation as a global leader in e-Governance depends on its ability to streamline ICT management and sustain its innovative public services. By proposing a standardized framework, the research aims to unify practices, improve collaboration, and optimize resource allocation, ensuring that public sector ICT can meet the growing demands for digital transformation. The findings are particularly relevant for tackling the challenges of fragmented systems, ambiguous roles, and inconsistent terminologies, which hinder effective change management and innovation.

Beyond Estonia, the research holds relevance for any government or organization seeking to address similar issues in ICT management. It provides a scalable model for standardizing managed objects, roles, and responsibilities, demonstrating how such frameworks can enhance operational clarity and efficiency. The proposed solutions contribute to global best practices in public sector ICT governance, offering insights for countries pursuing their own e-Governance ambitions. By focusing on standardization as a means to optimize digital service delivery, this research aligns with the broader international discourse on efficient, transparent, and sustainable public administration.

2 Methodology

This chapter outlines the methodological approach used to investigate the challenges in Estonian public sector ICT governance and propose solutions. The methodology combines professional insights, empirical data collection, and a review of academic literature to ensure a comprehensive and well-rounded investigation. By integrating qualitative observations with quantitative survey data, the research leverages a mixed-methods approach, enabling triangulation and a deeper understanding of the issues at hand.

The choice of a mixed-methods approach is supported by [21], who highlights its effectiveness in combining the strengths of qualitative and quantitative methodologies to address complex research questions. This design was particularly relevant, given the need to examine structural inefficiencies in ICT governance while validating findings across a broad stakeholder base.

2.1 Research design

The research was conducted in three key phases, each designed to build upon the other and ensure a thorough exploration of the problem. The first phase focused on contextual understanding through observations and desktop research, leveraging the researcher's extensive professional experience. The second phase involved a structured review of academic and policy literature to situate the problem within a broader theoretical framework. Finally, a quantitative CAWI survey was conducted to validate the findings and gather empirical data from stakeholders across Estonia's ICT management silos.

The rationale for this phased approach aligns with Yin's [22] case study methodology, which emphasizes using multiple sources of evidence to enhance the credibility of findings.

2.2 Observations and desktop research

The research began with an in-depth examination of the current state of ICT governance in Estonia, based on the researcher's professional experience. Having worked as both a management consultant and an active participant in Estonian ICT management silos, the researcher had firsthand insights into the fragmented nature of governance structures and the challenges associated with siloed operations.

To substantiate these observations, desktop research was conducted to identify supporting evidence from publicly available sources, policy documents, and academic literature. This phase helped refine the problem statement and ensured that initial claims were grounded in documented realities.

Such exploratory methods are particularly valuable in applied research contexts, as noted by Robson and McCartan [23], who argue that leveraging practitioner insights alongside documentary evidence strengthens the practical relevance of research outcomes.

2.3 Literature review

Building on the observations and desktop research, a literature review was conducted to establish the academic validity of the identified issues and explore potential solutions. The review focused on three main areas:

1. The importance of standardization in ICT governance frameworks (e.g., COBIT, ITIL).
2. The role of portfolio management in improving organizational efficiency and strategic alignment.
3. Best practices for assigning roles and responsibilities within ICT governance.

Key sources included works by Kaplan and Norton [24] on strategic alignment, Van Wessel and Ribbers [25] on the effects of IS standardization, and Markowitz's [26] foundational principles of portfolio management. These sources provided theoretical underpinnings that informed both the problem diagnosis and the proposed solutions.

2.4 CAWI survey

To gather empirical data and validate the research findings, a Computer-Assisted Web Interviewing (CAWI) survey was conducted in collaboration with the Ministry of Finance. This phase was pivotal in ensuring that the research addressed not only theoretical concerns but also practical realities as experienced by ICT governance stakeholders.

The survey design process involved creating a structured questionnaire using LimeSurvey, a commercial survey software. The questionnaire underwent iterative refinement in consultation with the Ministry to ensure clarity and relevance. Survey questionnaire is described in Appendix 2 – Survey questionnaire. To maximize response rates and build trust, an introductory letter was sent to potential respondents, explaining the survey's purpose and the importance of their participation. An online pre-survey briefing further clarified objectives, with the Ministry introducing the broader goals of the analysis and the researcher providing a detailed walkthrough of the survey.

The target population included representatives from ICT management silos across Estonia's public sector. While the total number of potential respondents in the public sector is large, the sample was carefully curated to focus on key stakeholders (ICT products and service provisioners, and public service managers, who represent the business side or the consumer domain of those services) from all ICT management domains. 48 completed responses were collected, covering ten of Estonia's eleven ministry domains - representing more than 90% of the ICT management landscape. The high level of domain representation underscores the validity and relevance of the data, even with a relatively small sample size.

2.5 Data analysis

Once the survey data was collected, it underwent rigorous processing and analysis. Responses were cleaned to ensure accuracy and completeness, then compiled into Microsoft Excel for quantitative analysis. Percentage distributions and frequency calculations were performed, and visual outputs were generated to facilitate interpretation. For data drilldown purposes in the analysis phase, Microsoft BI was also used.

The findings were analyzed to identify patterns, validate hypotheses, and draw actionable insights. These results were then presented to a steering group comprising high-level stakeholders, including the Estonian CIO (Luukas Ilves) and leaders from key ministry ICT silos. The group's feedback confirmed the feasibility and practical relevance of the findings, lending further credibility to the analysis.

Data visualization and statistical analysis in this phase followed best practices outlined by McNabb [27], who emphasizes the importance of clear, visual representations in interpreting and communicating research findings.

2.6 Ethical considerations

Throughout the research process, strict ethical standards were maintained. Participants were assured of their anonymity, and the survey included clear instructions on data confidentiality and voluntary participation. Informed consent was obtained both through the survey invitation and during the pre-survey briefing. The collaboration with the Ministry of Finance ensured alignment with public sector ethical guidelines, further reinforcing the credibility of the research process.

These ethical practices align with recommendations from Bryman [28], who highlights the importance of transparency and participant welfare in social research.

2.7 Methodological limitations

While the methodology was robust, certain limitations must be acknowledged. The reliance on professional experience and desktop research introduces an element of subjectivity, even when supported by external evidence. Additionally, the CAWI survey, while highly representative of ICT management domains, captured a relatively small number of responses. This could limit the generalizability of the findings to the broader public sector.

However, as Flyvbjerg [29] argues, the depth and specificity of case-based research often compensate for limitations in sample size, particularly when addressing complex, context-dependent problems.

3 Literature review

3.1 Need for standardization

Standardization is increasingly recognized as a strategic tool for enhancing organizational growth and efficiency. It encompasses the process of creating and implementing uniform policies, processes, and terminologies to ensure consistency across an organization. De Vries highlights that standardization fosters operational clarity, reduces ambiguity, and aligns resources with organizational goals, which is critical for scaling operations [30].

Standardized practices improve operational efficiency by streamlining processes and reducing redundancies. Van Wessel and Ribbers [25] demonstrate that standardization of information systems and business processes enhances performance and reduces variability, thereby increasing predictability in outcomes. Similarly in the realm of production, Lo and Yeung [31] emphasize that quality management standards like ISO 9000 drive process improvements and foster institutional stability, which are vital for scaling operations.

Organizational growth often brings complexities that can overwhelm existing management practices. Blind [32] asserts that standardization provides a framework to manage this complexity by offering clear procedural guidelines, especially during periods of rapid expansion. Moreover, Schilke et al. [33] argue that standardization in marketing and international operations enhances organizations capacity to innovate and adapt to new markets without compromising efficiency.

In multi-unit organizations, especially those operating across regions or sectors, standardization ensures interoperability. Wüllenweber et al. [34] point out that standardized workflows and terminologies facilitate collaboration across units, reduce miscommunication, and enable seamless integration of new entities during mergers or expansions. This ability to scale without compromising organization is fundamental to sustaining growth.

Standardization also delivers tangible financial benefits. By reducing the need for custom solutions and minimizing errors, it lowers operational costs. Hall [35] highlights that

efficiency gains from standardization translate into significant cost savings, making it an essential strategy for resource-constrained organizations.

Despite its positive impacts, implementing standardization is not without challenges. Resistance to change, especially in organizations with entrenched practices, can hinder adoption. Klochkov and Gazizulina [36] note that effective communication and involvement of stakeholders are critical to overcoming these barriers and ensuring successful implementation.

The need for standardized ICT governance in Estonia is underscored by persistent challenges such as duplicated IT services, resource-intensive operations, and fragmented management practices across silos. Lauk et al. [37] emphasize that these issues are not unique to Estonia but are part of broader global trends in technology governance, exacerbated by post-COVID demands for digital transformation. The study highlights how project-based development models and siloed IT management hinder adaptability and scalability, leading to inefficiencies in resource use and delays in service delivery. These findings align with the CAWI survey results, which identified similar challenges in Estonian public sector ICT governance. Standardizing portfolio management practices offers a pathway to address these inefficiencies by harmonizing processes, aligning priorities across domains, and reducing redundancy. Moreover, Lauk et al.'s strategic framework illustrates how unifying governance structures can strengthen interoperability, enabling cross-silo collaboration and ensuring that ICT investments align with overarching organizational goals.

While ICT management silos in Estonia are growing, cross-silo standardization seems to be the key to enable operations scalability and efficiency, while keeping costs growth under control and ensure cross-silo interoperability for fostering collaboration. While challenges exist, the long-term benefits in terms of operational stability, cost optimization, and strategic alignment make standardization an indispensable practice.

3.2 Standardizing governance frameworks

Standardized governance frameworks are critical for ensuring consistent, effective, and scalable ICT management across organizations. As the complexity of ICT ecosystems grows, these frameworks provide structured approaches for aligning technology with

business objectives and enabling interoperability. The integration of frameworks such as ITIL, COBIT, and ISO/IEC standards has become a cornerstone for organizations seeking to optimize ICT governance.

COBIT (Control Objectives for Information and Related Technologies) and ITIL (Information Technology Infrastructure Library) are two of the most widely used governance frameworks. Patón-Romero et al. [38] emphasize that COBIT provides a comprehensive approach to IT governance, focusing on aligning IT goals with business objectives, risk management, and performance measurement. ITIL, on the other hand, offers practical guidelines for managing IT services and processes, ensuring operational efficiency and service quality.

In the context of public sector ICT management, Renken [39] highlights the role of standardized governance frameworks in achieving maturity in information system management. Renken notes that frameworks like COBIT enable organizations to develop capabilities that support scalability and adaptability, which are crucial for public sector agencies dealing with cross-functional ICT systems.

Standardized governance frameworks streamline ICT management by reducing redundancies, improving resource allocation, and enhancing decision-making. Nfuka and Rusu [40] show that implementing governance frameworks leads to better accountability and transparency, particularly in public sector organizations. Additionally, Botterman et al. [41] noted in their study on ICT policy and governance that standardized practices minimize miscommunication and inefficiencies in multi-unit organizations.

Despite their advantages, implementing standardized governance frameworks is not without challenges. Kanevskaia [42] points out that resistance to change, lack of stakeholder buy-in, and resource constraints often hinder the adoption of these frameworks. Furthermore, adapting global standards to local contexts requires careful customization, as noted by Balta [43] in the context of e-Government standardization.

The growing complexity of ICT systems and the push for interoperability across silos have underscored the need for unified governance frameworks. Van Wessel [44] argues that a unified framework ensures consistency in managing ICT resources and aligns organizational goals with IT strategies. Unified governance frameworks, such as the

integration of COBIT, ITIL and ISO/IEC standards, provide a comprehensive approach to managing ICT risks, compliance, and service delivery.

Many researchers encourage standardization of governance frameworks and their implementation. Standardized governance frameworks are good fit for adoption although customization to local circumstances is recommended. Estonia should consider providing standardized governance framework for adoption in its ICT management silos to enhance efficiency, collaboration, and interoperability, ensure better compliance and alignment to strategies, and enable scalability.

3.3 ICT management silos output standardization

ICT management silos in public sector organizations are responsible for delivering diverse outputs to support governmental functions. These outputs include services, systems, and infrastructure designed to enable public services and internal operations. ICT management silos are tasked with delivering outputs that align with organizational goals and public service delivery needs. These outputs commonly include IT services, information systems, infrastructure, but also data and analytics. Managed objects within silos are considered to be the building blocks of these outputs, and they are usually defined as hardware, software, data, processes, or services. Misuraca and Viscusi [45] argue that the lack of a standardized approach to defining and categorizing these objects complicates interoperability and hinders cross-silo collaboration in ICT management.

The lack of standardized terminology and frameworks for managed objects in ICT silos results in challenges in interoperability, duplication of effort and inconsistent quality. Tate et al. [46] highlight that standardizing managed objects can mitigate these challenges by creating a common language and processes across silos.

Standardization of managed objects terminology would allow the formulation of standardized sets of managed objects across silos. Halmos [47] notes that by treating managed objects as elements of well-defined sets, organizations can standardize their categorization and relationships, enabling more efficient management and interoperability. This would apply within each Estonian ICT management silo, but also across management silos for their output sets and associated managed objects sets.

3.4 Portfolio management approach to standardization

Portfolio management involves grouping related objects into portfolios to optimize their management. The concept of portfolio management originates from financial management principles described by Markowitz [26] and has evolved over time into a strategic framework applied across various domains, including ICT, project management, and resource management.

De Vries [30] highlights that standardized approaches in portfolio management enhance interoperability and decision-making by reducing ambiguity in managing resources or objects. Standardization ensures that all objects within a portfolio share a consistent framework, facilitating comparisons and prioritization.

The application of portfolio management practices for standardization in public services has proven effective in enhancing coordination, resource allocation, and strategic alignment across various initiatives. In Lithuania, Chmieliauskas et al. [48] documented how standardized portfolio management practices were implemented in public sector organizations to align projects and programs with consistent methodologies, improving decision-making and resource utilization. Similarly, the CGIAR initiative, studied by Schut et al. [49], demonstrates how innovation portfolio management was used to streamline processes and enhance coordination across multiple stakeholders in the food systems sector, showcasing the benefits of standardization for complex, multi-stakeholder public services.

In Australia, Young et al. [50] explored the adoption of a whole-of-enterprise portfolio management approach by the New South Wales Government and Sydney Water Corporation. This approach enabled integrated planning and execution of diverse projects, ensuring that public service initiatives adhered to standardized practices for greater efficiency and accountability. In Brazil, Rezende and Gonçalves [51] highlighted how portfolio management was applied to optimize decision-making in public-sector investments, providing a structured framework to prioritize projects and standardize service delivery processes.

Another notable example is found in European smart city initiatives. Anthopoulos et al. [52] examined how public-sector organizations leveraged portfolio management to standardize the planning and execution of smart services, leading to improved

interoperability and efficiency in digital transformation projects. These cases collectively demonstrate that portfolio management, when standardized, provides a robust framework for achieving strategic alignment, optimizing resources, and enhancing the effectiveness of public service delivery in diverse contexts.

4 Survey findings

4.1 Respondent demographics

The survey was taken by 48 respondents across government management silos. 30 respondents from 9 different government management domains were representing the ICT products and services managers or provisioners in those domains, 18 respondents from 11 different government domains were representing consumer domains of those products or services.

Table 1. Demographic distribution between survey respondents.

	Government domain	**Count of ICT Managers/ Provisioners**	**Count of ICT Clients**
1	Ministry of Finance	7	4
2	Ministry of Economic Affairs and Communications	6	4
3	Ministry of the Interior	4	1
4	Ministry of Justice	3	1
5	Ministry of Climate	3	2
6	Government Institution	3	1

7	Ministry of Regional Affairs and Agriculture	2	1
8	Local Governments	1	0
9	Ministry of Foreign Affairs	1	1
10	Ministry of Defence	0	1
11	Ministry of Culture	0	1
12	Ministry of Social Affairs	0	1
	Total	**30**	**18**

Out of Estonian 11 ministries, 10 are represented in selection (only the Ministry of Education and Research domain is not represented). Additionally, there are representation from government institutions (like Government Office or Data Protection Inspectorate) that reside separate from the ministries, and local government (The Association of Estonian Municipalities). With the inclusion of Ministry of Education and Research, the total sample count of Government domains would be 13. 12 domains out of those 13 are represented in the survey responses, 9 from the ICT management and provisioning side, and 11 from the ICT products and services consumer side. This can be considered as representative sample of the overall research domain.

4.2 Usage of management practices across domains

The analysis of management practices across domains reveals distinct trends, shaped by the priorities and capacities of organizations. **Business Process Management (BPM)** is the most widely adopted practice, with 85% of respondents indicating its use in their organizations. This reflects a strong focus on enhancing operational efficiency and streamlining workflows, a priority that transcends the boundaries of individual domains. The high adoption rate underscores the universal importance of structured process management in achieving organizational goals.

Product Management follows closely, with 78% of respondents reporting its application. This practice is particularly prevalent in domains like the Ministry of Justice and the Ministry of Climate, where delivering impactful products or services to end-users is a core function. The widespread use of Product Management highlights the emphasis placed on ensuring that offerings meet user needs and align with organizational strategies.

In contrast, **Service Management** shows a lower adoption rate of 52%. While it is integral in service-focused domains such as the Ministry of Social Affairs, its inconsistent application across other areas suggests that not all organizations prioritize or emphasize direct service delivery as part of their strategic objectives. This variance may reflect differences in operational focus, with some domains concentrating more on internal processes rather than outward-facing services.

Business Architecture Management, with a reported usage rate of 45%, reveals a more selective adoption pattern. This practice, which involves the strategic alignment of organizational capabilities and structures, is more commonly utilized in larger domains or those with complex mandates, such as the Ministry of Economic Affairs and Communications. The relatively lower usage indicates that not all domains currently prioritize such comprehensive strategic oversight.

Portfolio Management emerges as the least utilized practice, with only 30% of respondents indicating its use. This suggests that structured approaches to balancing and overseeing projects, processes, and services are still in their developmental stages within many organizations. However, its adoption is more noticeable in project-driven domains, such as the Ministry of the Interior, where it supports the alignment of projects with strategic goals.

4.3 Usage of frameworks and practices for ICT

Following is the overview of ICT frameworks and principles usage across researched domains.

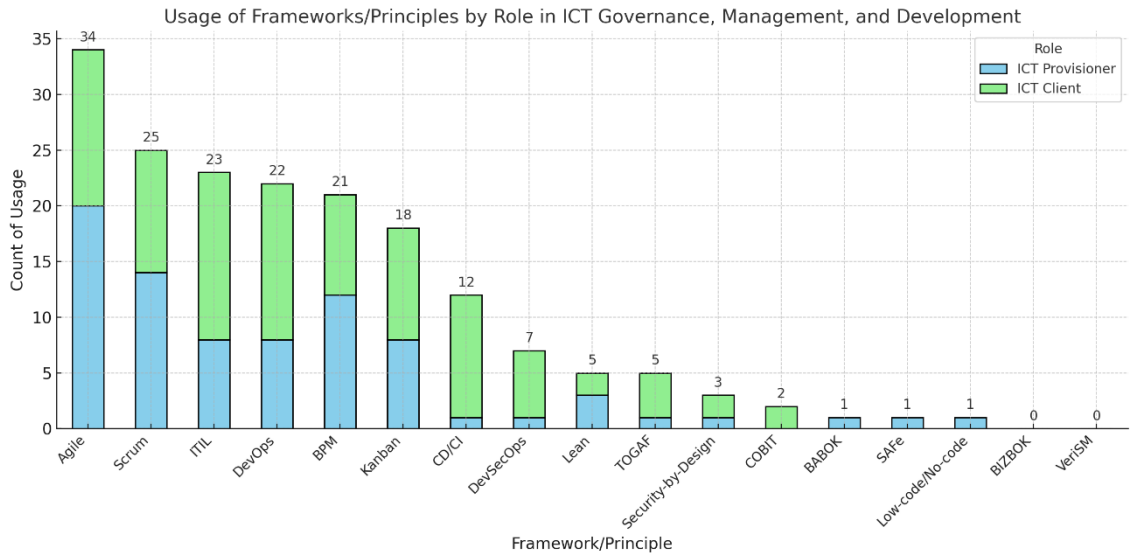

Figure 1. Usage of frameworks/principles in ICT governance, management, development and maintenance.

The data highlights a strong reliance on Agile and related frameworks like Scrum and DevOps, which are particularly well-suited for modern, iterative development practices. Meanwhile, the lower adoption of specialized frameworks like COBIT [18] or TOGAF [53] suggests that not all organizations are yet fully leveraging strategic IT governance or architecture practices. The variations in usage between ICT provisioners and clients underscore their differing priorities: provisioners lean towards tools that enhance delivery and workflow management, while clients focus on processes that align products and services with broader organizational goals.

But as each of those frameworks and principles target different layers of ICT organizations operating model levels, then the overview becomes more clearer when results are looked in the categorized manner. Following is a table illustrating each framework or practice (rows) against four broad categories—ICT governance, ICT management, ICT development, and ICT maintenance (columns).

Table 2. Frameworks/principles focus map for organization operating model levels.

Organization operating model level	**Governance layer**	**Management layer**	**Operational layer**

Practice/ Framework	ICT Governance	ICT Management	ICT Development	ICT Maintenance
Agile		○	●	○
BABOK		●	○	○
BIZBOK	●	○		
BPM	○	●		○
COBIT	●	●		
CD/CI		○	●	●
DevOps		○	●	●
DevSecOps		○	●	●
ITIL	○	●		●
Kanban		○	●	●
Lean		○	●	●
Low-code/No-code			●	○
SAFe		○	●	○
Scrum			●	○
TOGAF	●			
VeriSM	○	●		●
Security-by-Design		○	●	●

Markings in the cells indicate a primary (●) or secondary (○) relevance of that framework in current category. Some frameworks and methods span multiple domains, so

overlapping areas are noted accordingly. Primary (●) marks the domain of application for the principal/framework main value proposition and focus. Secondary (○) means that it is often applied or integrated in this domain but not the framework's main focus. The green background colour in the table indicates for the most used framework or practices by respondents in each categories.

The findings across the governance, management, and operational layers paint a clear picture of how frameworks and practices are distributed and valued within ICT organizations. By combining insights from the Figure 1. Usage of frameworks/principles in ICT governance, management, development and maintenance. with the Table 2. Frameworks/principles focus map for organization operating model levels., we can see patterns of adoption and focus, shaped by the specific needs of each layer.

In the **governance layer**, the focus lies on strategic oversight, alignment, and accountability. TOGAF and COBIT frameworks emerge as primary tools for guiding ICT governance efforts, where they establish policies and ensure alignment between IT systems and organizational goals. TOGAF's structured approach to enterprise architecture and COBIT's emphasis on control and evaluation make them natural choices for this layer. Despite their niche presence overall—COBIT, for instance, was mentioned only 2 times in the survey—their relevance is amplified when it comes to governance. Meanwhile, frameworks such as ITIL and BIZBOK are applied in governance as secondary tools, signalling their supportive roles. ITIL, though primarily focused on IT service delivery, finds its way into governance with 23 mentions overall, reflecting its flexibility. BPM and Kanban, typically associated with processes and workflows, also appear in governance to a lesser extent, showing that process optimization principles sometimes overlap with broader governance needs.

In the **management layer**, the picture shifts significantly as frameworks and practices designed for process optimization, service management, and workflow control take centre stage. BPM (Business Process Management) stands out as a core framework in ICT management, with 21 mentions overall, and its dominance in this layer reflects the need to design, streamline, and oversee business processes. ITIL also emerges as a primary framework in this layer, demonstrating its role in managing IT services and ensuring alignment with business objectives. Its balanced adoption across ICT provisioners and clients further underlines its importance as a bridge between business needs and IT

operations. Kanban, too, plays a primary role, reinforcing its value in visualizing workflows and improving task management. Frameworks like Agile and Lean appear here as secondary tools, showing their adaptability to management tasks, though their primary focus lies elsewhere. The strong presence of BPM, ITIL, and Kanban signals a clear organizational need for structured yet adaptable management practices to navigate complex ICT landscapes.

The **operational layer**, divided between ICT development and ICT maintenance, shows the broadest adoption of frameworks, with an emphasis on practical execution, flexibility, and continuous improvement. In ICT development, Agile and Scrum dominate, as seen both in the table and the data, where Agile received 34 mentions and Scrum 25 mentions, making them the most used frameworks overall. Their iterative approaches to development align perfectly with the fast-paced demands of ICT projects. DevOps also plays a crucial role, with 22 mentions, reflecting its value in enhancing collaboration between development and operations teams while enabling automation. Frameworks like CD/CI and DevSecOps appear as supporting tools in development, signalling a growing focus on continuous delivery pipelines and integrated security practices. Meanwhile, Kanban, which was adopted 18 times, balances development workflows, offering a lean approach to managing tasks effectively.

Overall, the findings underscore how frameworks align with specific organizational needs across layers. The governance layer relies on specialized tools like TOGAF and COBIT to provide strategic direction, while the management layer thrives on process optimization through BPM, ITIL, and Kanban. In the operational layer, Agile, Scrum, and DevOps dominate ICT development, reflecting their adaptability and flexibility, whereas ITIL and Kanban ensure effective maintenance.

While the diversity of management practices highlights organizational efforts to optimize workflows and achieve strategic goals, it also points to a potential gap in role clarity. The absence of a unified, standardized approach can create challenges in accountability, coordination, and communication across domains. To address this, organizations may benefit from clearly articulating the purpose and ownership of each framework and aligning them with well-defined roles at each organizational layer - governance, management, and operations.

4.4 Process management responsibilities

Following is the mapped distribution of responsibilities for process management.

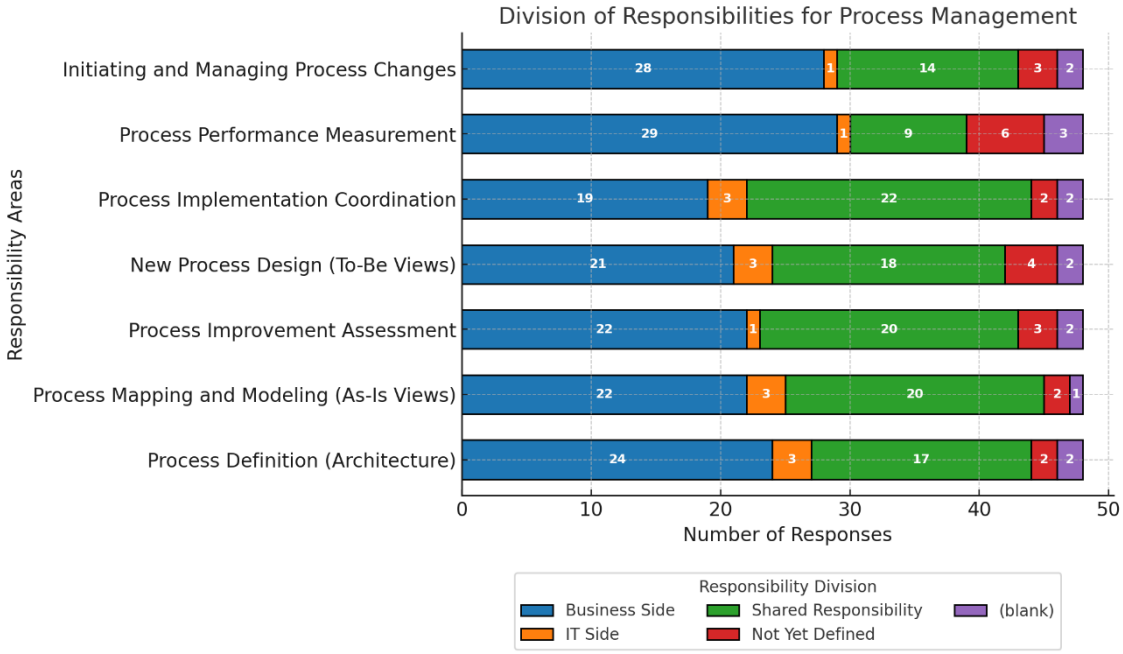

Figure 2. Division of Responsibilities for Process Management.

Figure 2. Division of Responsibilities for Process Management. highlights several key findings. The business side emerges as the dominant driver across most process-related tasks, particularly in areas like Initiating and Managing Process Changes and Process Performance Measurement, where it holds 58% (28/48) and 60% (29/48) of the responses, respectively. This reflects its strategic leadership in initiating change and evaluating process outcomes.

Meanwhile, IT's role is more pronounced in Process Implementation Coordination, where it leads with 46% (22/48) of the responses, highlighting its operational responsibility in implementing processes. Collaboration between the business side and IT is significant in tasks such as New Process Design (To-Be Views) and Process Improvement Assessment, where shared responsibility accounts for 38% (18/48) and 42% (20/48), respectively. This underscores the need for alignment between strategy and technical feasibility in designing and improving processes.

Gaps in clarity are notable but minimal, with Not Yet Defined responses averaging between 6-8% across tasks, and blank responses contributing around 4-6%. These gaps suggest opportunities for better role formalization in certain areas.

Overall, the findings demonstrate that while the business side leads in strategy and evaluation, IT takes ownership of implementation, and collaboration is key in areas requiring alignment between business goals and technical execution.

4.5 Product management responsibilities

Following is the mapped distribution of responsibilities for product management.

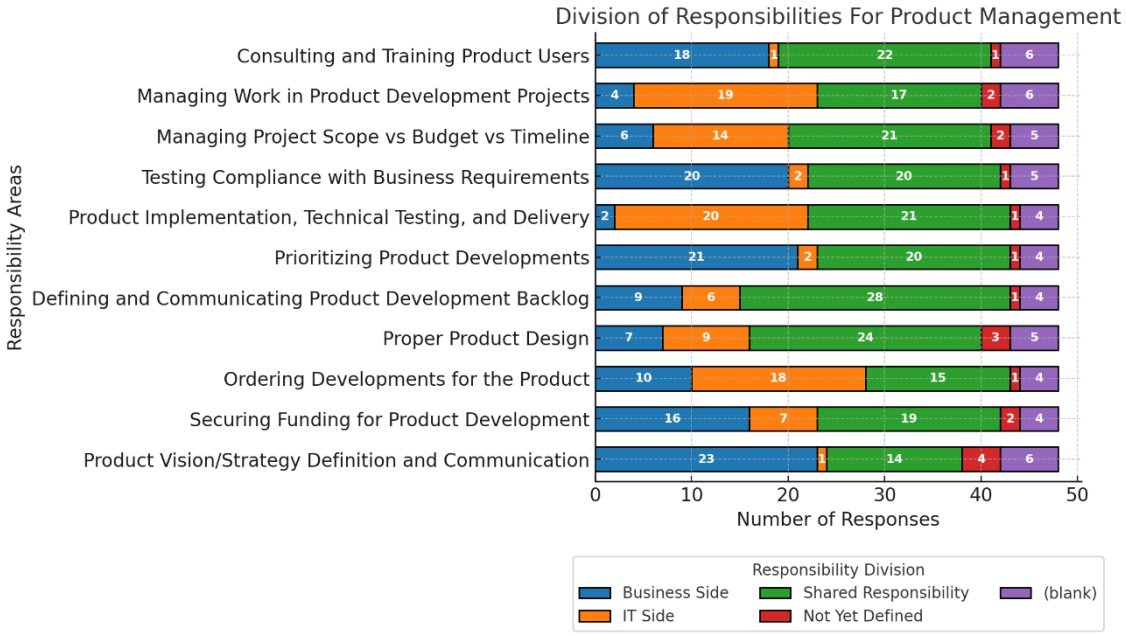

Figure 3. Division of Responsibilities for Product Management.

Figure 3. Division of Responsibilities for Product Management. reveals clear trends in role allocation between the business side, IT, and shared responsibilities, highlighting patterns of leadership and collaboration across tasks.

The business side takes a leading role in strategic and funding-related responsibilities. For example, Product Vision/Strategy Definition and Communication is primarily driven by the business side, with 48% (23/48) of responses, while shared responsibility accounts

for 29% (14/48). Similarly, Securing Funding for Product Development sees the business side dominating with 33% (16/48), while IT contributes a smaller share of 15% (7/48).

Collaboration is a defining feature in tasks requiring alignment between strategic goals and technical execution. For instance, Prioritizing Product Developments and Defining and Communicating Product Development Backlog show strong shared responsibility, with 42% (20/48) and 38% (18/48) of responses, respectively. This highlights the need for close coordination between the business and IT sides in managing development priorities effectively.

The IT side takes a stronger role in technical and implementation-focused tasks. In Product Implementation, Technical Testing, and Delivery, IT leads with 44% (21/48) of responses, reflecting its operational expertise. Similarly, Managing Work in Product Development Projects sees IT assuming a significant role with 40% (19/48) of responses.

Certain tasks exhibit more evenly distributed responsibilities. For example, Testing Compliance with Business Requirements highlights shared responsibility in 42% (20/48) of responses, while the business side contributes 31% (15/48), and IT accounts for 21% (10/48). This balanced approach reflects the interconnected nature of ensuring business alignment and technical quality.

Minor gaps remain in role clarity, with Not Yet Defined responses averaging around 6%, particularly in tasks like Ordering Developments for the Product and Proper Product Design.

In summary, the findings show that the business side leads in strategic vision, funding, and user-oriented tasks, while IT takes charge of implementation and technical delivery. Shared responsibility emerges as a consistent theme in backlog management, prioritization, and compliance testing, highlighting the need for collaboration to align business needs with technical execution.

4.6 Service management responsibilities division

Following is the mapped distribution of responsibilities for service management.

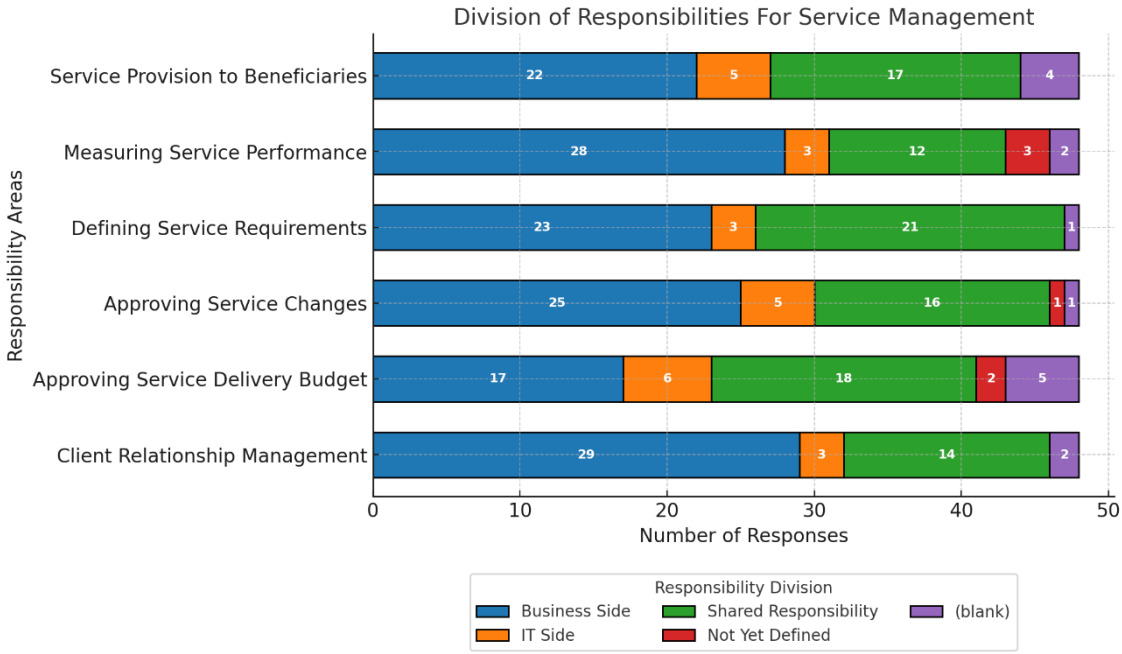

Figure 4. Division of Responsibilities for Service Management.

Figure 4. Division of Responsibilities for Service Management. highlights key patterns in how responsibilities are distributed across business, IT, and shared roles, with distinct areas of leadership and collaboration.

Client Relationship Management is overwhelmingly led by the business side, with 60% (29/48) of responses assigning responsibility here. Shared responsibility accounts for 29% (14/48), showing some collaboration, while the IT side contributes minimally at 6% (3/48), reflecting the business-driven nature of managing client relationships.

In Approving Service Delivery Budget, the task is more collaborative, with 38% (18/48) marking it as a shared responsibility. The business side still holds a significant role at 35% (17/48), while IT contributes 13% (6/48), suggesting occasional involvement in budget-related decisions. Gaps emerge here, as 4% (2/48) of responses remain undefined, and 5% (5/48) are blank.

Approving Service Changes shows similar collaboration, with 33% (16/48) indicating shared responsibility. The business side leads with 52% (25/48), emphasizing its authority over decision-making, while IT assumes 10% (5/48) of responses. Minor gaps exist, with 2% (1/48) not yet defined.

Defining Service Requirements highlights strong collaboration, with 44% (21/48) of responses identifying shared responsibility. The business side leads here as well, with 48% (23/48), reflecting its focus on aligning service needs with organizational goals. IT contribution is minor at 6% (3/48), while only 2% (1/48) remain blank.

Measuring Service Performance shows the business side leading again with 58% (28/48), reflecting its accountability for evaluating service outcomes. Shared responsibility accounts for 25% (12/48), while IT contributes a smaller 6% (3/48). Not Yet Defined responses and blanks together make up 10% (5/48), indicating some gaps in clarity.

Lastly, in Service Provision to Beneficiaries, responsibility is distributed more evenly, though the business side still leads with 46% (22/48). Shared responsibility is significant, at 35% (17/48), highlighting collaboration in service delivery. IT contributes 10% (5/48), while 8% (4/48) of responses remain blank.

Overall, the data underscores that the business side dominates in strategic and decision-making responsibilities, such as budget approval, client relationships, and defining service requirements. Shared responsibility is notable in areas requiring alignment between business goals and service operations, such as approving changes and measuring performance. IT role is more limited but emerges in specific technical areas like supporting service delivery. Minor gaps in responsibility assignment, averaging around 5-8%, suggest opportunities to formalize roles further.

4.7 Business architecture management responsibilities

Following is the mapped distribution of responsibilities for business architecture management.

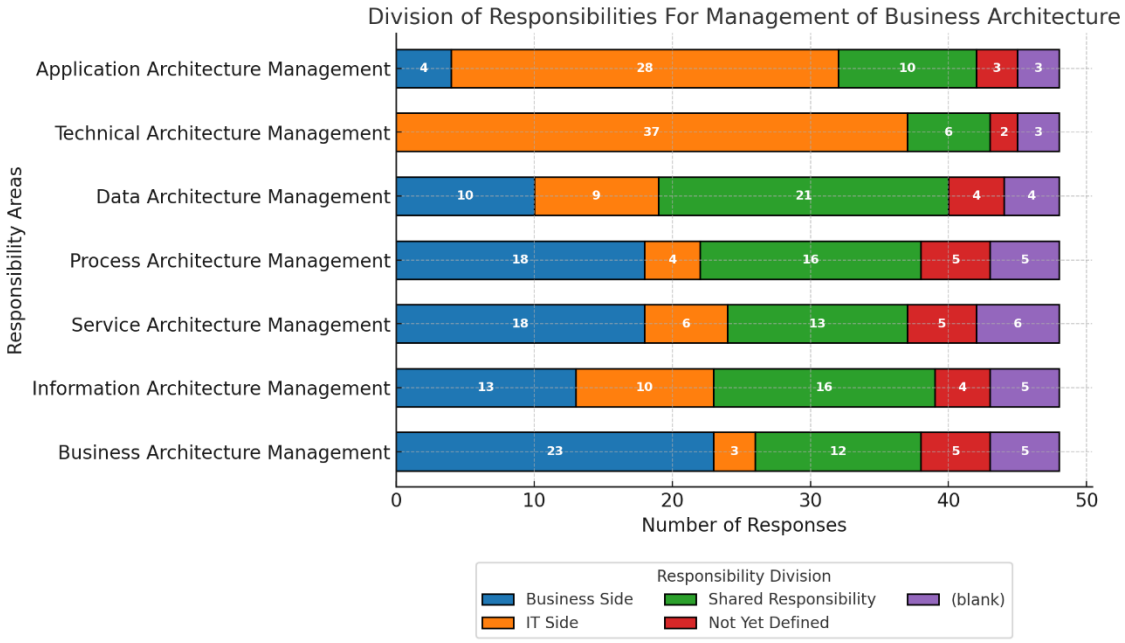

Figure 5. Division of Responsibilities for Management of Business Architecture.

Figure 5. Division of Responsibilities for Management of Business Architecture. reveals distinct patterns in how tasks are allocated between the business side, IT, and shared responsibilities, emphasizing clear technical dominance in certain areas and collaboration in others.

Technical Architecture Management is heavily driven by IT, with 77% (37/48) of respondents assigning responsibility here, making it the most IT-dominated task. Shared responsibility is minimal at 13% (6/48), and only 4% (2/48) of responses indicate gaps or undefined roles.

Application Architecture Management also sees strong IT ownership, with 58% (28/48) of the responsibility assigned to IT. The business side contributes minimally at 8% (4/48), while 21% (10/48) of responses highlight shared responsibility, reflecting a need for coordination in aligning applications with business goals.

In Data Architecture Management, shared responsibility emerges more prominently, accounting for 44% (21/48) of responses. IT holds 19% (9/48) of the responsibility, while the business side contributes 21% (10/48). Notably, 8% (4/48) of responses remain undefined, indicating some ambiguity in formal role assignment.

Process Architecture Management shows a stronger role for the business side, with 38% (18/48) of respondents placing responsibility there. Shared responsibility follows closely at 33% (16/48), reflecting the need for alignment between strategy and technical implementation. IT contributes 8% (4/48), while 10% (5/48) of responses remain undefined or blank, highlighting minor gaps.

For Service Architecture Management, the business side again leads, with 38% (18/48) assigning responsibility here. Shared responsibility accounts for 27% (13/48), while IT holds 13% (6/48). However, 15% (7/48) of responses indicate gaps, with roles either undefined or blank.

Information Architecture Management highlights a balanced distribution, with 33% (16/48) of responses indicating shared responsibility. The business side takes 27% (13/48), while IT accounts for 21% (10/48), reflecting the collaborative nature of managing information structures. Gaps remain in 17% (8/48) of responses, suggesting areas for clarification.

Finally, Business Architecture Management sees the business side taking clear ownership, with 48% (23/48) of responses. Shared responsibility accounts for 25% (12/48), emphasizing collaboration, while IT contribution remains low at 6% (3/48). Notably, 21% (10/48) of responses indicate gaps, with roles either undefined or blank, marking this as an area needing greater formalization.

In summary, the findings reveal that IT dominates technical areas, such as technical and application architecture management, while the business side leads in business-oriented tasks, such as process and business architecture management. Shared responsibility is most evident in data and information architecture management, reflecting the interconnected nature of these areas. However, gaps in role clarity, particularly in service and business architecture management, suggest opportunities for improved formalization and alignment.

4.8 Portfolio management responsibilities

Following is the mapped distribution of responsibilities for portfolio management.

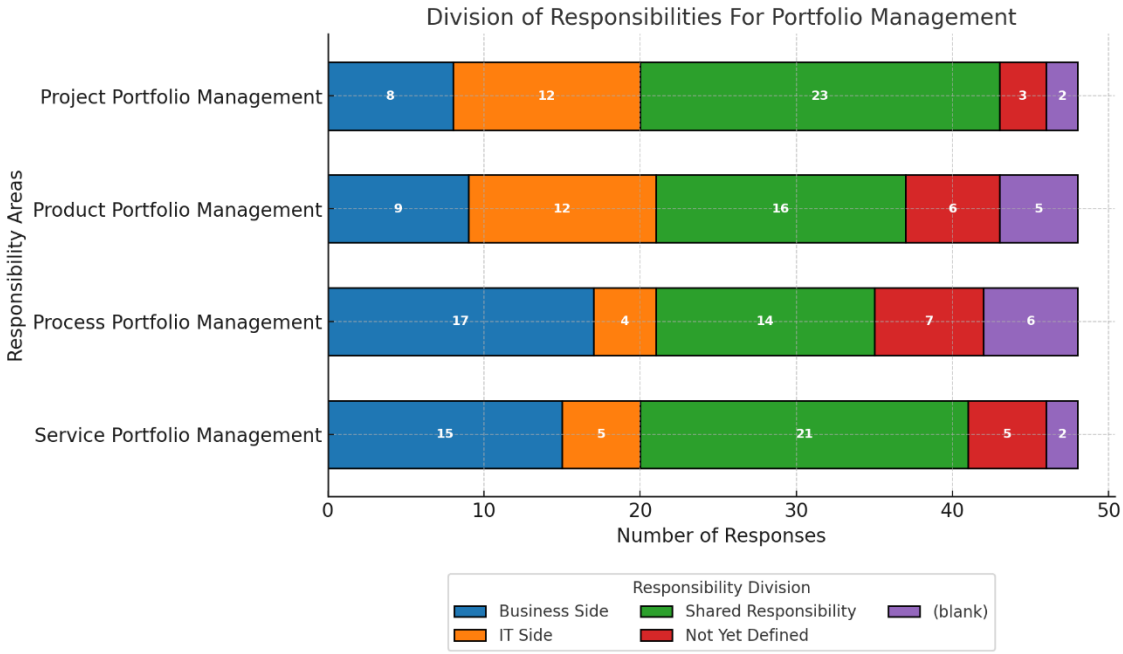

Figure 6. Division of Responsibilities for Portfolio Management.

Figure 6. Division of Responsibilities for Portfolio Management. highlights patterns in role distribution across the business side, IT, and shared responsibilities, with distinct trends in collaboration and clarity gaps.

In Project Portfolio Management, shared responsibility dominates, with 48% (23/48) of responses indicating collaboration between business and IT. The IT side contributes 25% (12/48), reflecting its role in technical oversight, while the business side accounts for 17% (8/48). Minor gaps emerge, with 6% (3/48) of roles marked as not yet defined and 4% (2/48) left blank.

Product Portfolio Management reveals balanced roles, with 33% (16/48) of responses indicating shared responsibility. IT holds a significant role, with 25% (12/48) of responses, reflecting its involvement in technical aspects of product portfolios. The business side contributes 19% (9/48), but notable gaps appear, as 13% (6/48) of responses are not yet defined, and 10% (5/48) remain blank.

Process Portfolio Management sees the business side taking a leadership role, with 35% (17/48) of responses. Shared responsibility follows at 29% (14/48), showing collaboration

between business and IT. IT's role is smaller, at 8% (4/48), while gaps are notable here, with 15% (7/48) marked as not yet defined and 13% (6/48) left blank.

In Service Portfolio Management, shared responsibility dominates, with 44% (21/48) of responses highlighting collaboration. The business side holds 31% (15/48) of the responsibility, while IT contributes 10% (5/48). Gaps remain low, with 10% (5/48) marked as not yet defined and 4% (2/48) blank.

Overall, the findings show that shared responsibility is the most significant trend across portfolio management tasks, particularly in Project Portfolio Management and Service Portfolio Management, where collaboration is essential. The business side leads in process portfolios, reflecting its strategic oversight, while IT takes a stronger role in product portfolios. Gaps in clarity, particularly in process and product portfolios, suggest opportunities to formalize roles further and ensure greater accountability.

4.9 Understandability and clarity

Following are the results for surveying respondent's understandability of the ICT development responsibilities within their organization and also their own individual responsibilities. Also, the clarity of used terminology in the survey was validated.

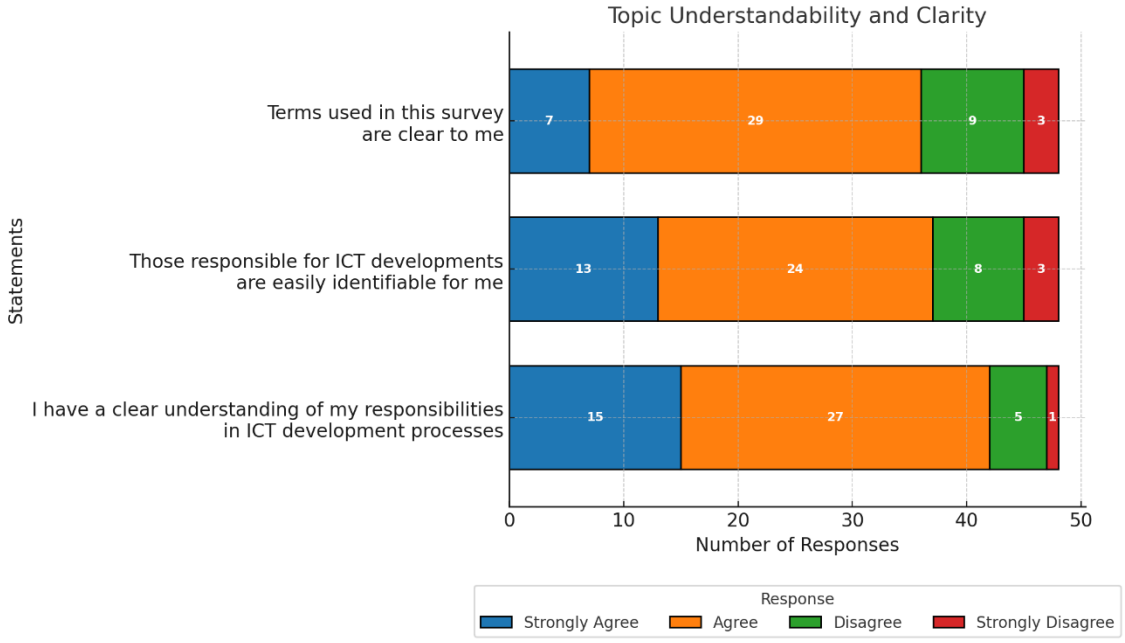

Figure 7. Understandability and clarity of responsibilities and terminology.

In the statement "I have a clear understanding of my responsibilities in ICT development processes," the results are overwhelmingly positive, with 88% of respondents (15 strongly agree, 27 agree) affirming clarity in their responsibilities. Only 12% express uncertainty, suggesting that most individuals have a well-defined understanding of their roles.

For "Those responsible for ICT developments are easily identifiable for me," while 77% of respondents (13 strongly agree, 24 agree) find ICT roles easy to identify, 23% (8 disagree, 3 strongly disagree) report challenges. This highlights the need for better communication or visibility to ensure all stakeholders can clearly identify ICT responsibilities.

In "Terms used in this survey are clear to me," 75% (7 strongly agree, 29 agree) indicate that the terminology is clear, but 25% (9 disagree, 3 strongly disagree) struggled with understanding. This reveals a notable gap, suggesting that clearer or more accessible language could improve comprehension for a significant portion of respondents.

The results show that respondents generally feel confident about their responsibilities in ICT development processes and are largely able to identify those responsible for ICT developments. However, 25% of respondents indicate issues with the clarity of terms used in the survey, making this the most prominent area for improvement. Addressing terminology clarity and improving the visibility of ICT responsibilities could enhance overall understanding and communication within the organization.

4.10 Survey summary

Out of the total respondents, 32 individuals (approximately 67%) answered "No" to using certain management practices (section 2 of the questionnaire) but still assigned specific responsibilities under those same categories (to either the business side, IT side, or shared responsibility in sections 3 to 7 in the questionnaire). This contradiction suggests a potential misalignment between the reported adoption of practices and the actual role distribution within organizations. Author concludes from this, that although managed objects are not clearly defined in the organizations management practices, the management responsibilities of these objects are being still fulfilled and necessary.

The survey results demonstrate that organizations are aware of the importance of portfolio management but face challenges in clearly defining and formalizing roles. The high

percentages of shared responsibility across all portfolio categories suggest a need for stronger coordination between business and IT. Results clearly emphasize the need to define clearer responsibilities in managing portfolio objects between the business side and IT. Across all portfolio management categories there is a consistent trend of shared responsibilities, coupled with notable ambiguity and undefined roles. This pattern highlights both the existing collaboration and the underlying challenges caused by unclear delineation of responsibilities. Results underscore a recurring theme: collaboration between business and IT is essential for managing portfolio objects, but a lack of clearly defined responsibilities can create inefficiencies, role overlaps, and decision-making gaps.

The survey results also highlight both opportunities and challenges in creating unified ICT products and services portfolios across all ICT management domains. The findings reveal a fragmented yet collaborative landscape where responsibilities are shared between the business side and IT, but gaps in clarity and ownership persist. These patterns indicate that while there is recognition of the need for integrated management, significant steps must be taken to formalize and unify portfolios.

The survey findings additionally underscore a clear need for standardizing terminology across ICT management silos, as inconsistent or unclear language appears to impact understanding and role clarity. This need becomes particularly evident when we consider the results regarding terminology clarity alongside other findings in the survey. When viewed alongside broader survey results, such as fragmented management practices, overlapping responsibilities, and shared ownership across business and IT domains, it becomes apparent that inconsistent terminology exacerbates these challenges. Without standardization, silos can develop their own definitions for roles, processes, and priorities, leading to misalignment and inefficiencies.

5 Proposed standardization

5.1 Defining managed objects

In 2023, a survey report called “Analysis and operational model for ICT service delivery and development in ministries” for the Ministry of Finance proposed amongst other things a standardized terminology for managed objects [54] in Estonian public sector and its ICT management silos. During the analysis, the proposed terminology was synthesized from different ICT governance and management frameworks and translated into the context of Estonian public sector. The understandability of the terminology was validated with the ICT services provisioners and public service provisioners and with the ICT management representatives from 3 ministries (including CIO of Estonia) and its sub-institutions.

The terminology was based on the following conceptual model of customized service value stream with its managed objects and their relations.

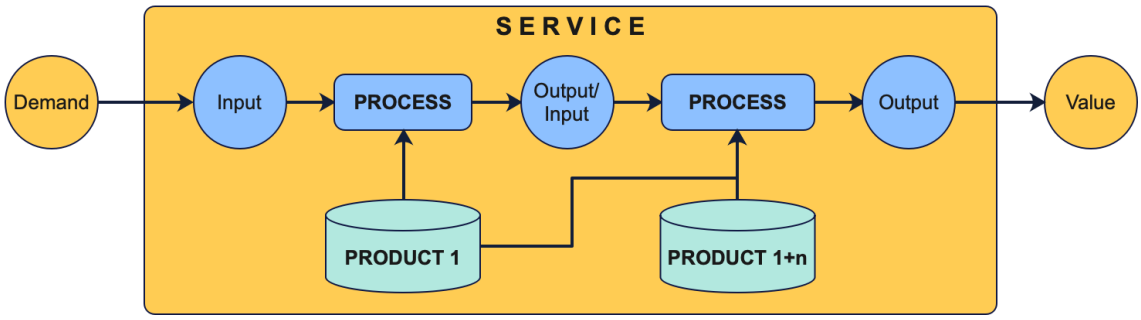

Figure 8. Conceptual model of service value stream objects and its relations.

Following are the managed object definitions according to the model and the proposed terminology.

A **service** is the result of the co-creation of **processes** and **products**, the operation of which delivers the desired value of the customer (beneficiary in terms of ICT management) to the user (the beneficiary in terms of the result of the provision of the service, incl. the user of the product). The service exists only at the time of its provision.

A product is a configuration of resources that is used to create value for beneficiaries. The product exists continuously regardless of its use or non-use.

Process - a set of interrelated or interacting activities that transform inputs into outputs. A process takes one or more defined inputs and turns them into defined outputs. Processes define the sequence of actions and their dependencies.

A resource is a person or other physical (computer, refrigerator, item, object) or virtual (software, database, data) entity that is necessary to carry out an activity or achieve a goal. The resources used by the organization may belong to the organization itself (own employees, servers) or be used in accordance with the contract with the resource owner (outsourced programmers, data centre).

Author uses this terminology in as the basis for standardization but proposes to specify the terminology even further by, cross-referencing them with ITIL v4 [17] terminology and bringing in the context that these defined objects are being managed in Estonia, so that interrelations between the objects in different contexts would become clearer for portfolio management purposes.

Proposition is to divide these terms into two contexts. First would be the ICT management silo context, who is providing ICT products and services, and the other would be the context of the consumer of those services, who uses ICT products and services. Although both management domains contribute to the same value creation in terms of public service output, the resource pools through which organizations provide their outputs are managed separately. These separate resource pools are the result of past ICT domain consolidations and will likely remain separate in future consolidations as well. This is because managing consolidated resource pools requires less effort, making this approach practical and reasonable. Uddin [55] demonstrates in his research of virtualization implementation that consolidation reduces operational overhead, optimizes hardware usage and enhances cost-effectiveness by pooling resources centrally.

In the Estonian public sector, ICT competence centres – IT-houses and departmental ICT competence centres – provide support with their outputs to the public service provisioning. In most cases, it means that ICT products and services are provided to other government institution, who have the responsibilities to manage and provision public services. But in the cases of departmental ICT competence centres within organizations responsible for providing public services, the outputs are provided for their own organization other units as well. In these examples, the customer for the ICT services is

public services provisioning – also often referred to as the business side of public sector, or business consumers.

But not all the products managed in the ICT management silo are products directly for business consumer. Some of them are ICT products that are used by management silo itself in order to provide ICT products for business use. And this use could be internal or across silos. Good example of internal use would be a network traffic monitoring software product. In this case ICT product consumer is ICT management silo itself. Across silo example would come from consolidated infrastructure services. In Estonia, RIT is providing infrastructure services as its silo output for other ICT management silos. These cases illustrate the need for generalized definition of customer – customer for ICT management silos output can be from business domain or from ICT domain and organizational wise can be internal or external. This means that standardized and unified ICT products and services portfolios would contain objects with that kind of differentiation for the purposes of exposing only relevant objects to their consumers.

As seen from the conceptual model (Figure 8. Conceptual model of service value stream objects and its relations.), there are 3 main objects that could be a potential candidates for forming management portfolios within service value stream – service, process and product. And from the definitions, fourth object is described – a resource. For portfolio management purposes definition of managed objects sets have to be given in order to establish portfolio outlining – to understand what belongs to the portfolio and what doesn't. Keeping in mind the need for the defined context, and standardized terminology, author proposes a conceptual model how to systematically approach to defining ICT managed object sets on the following diagram.

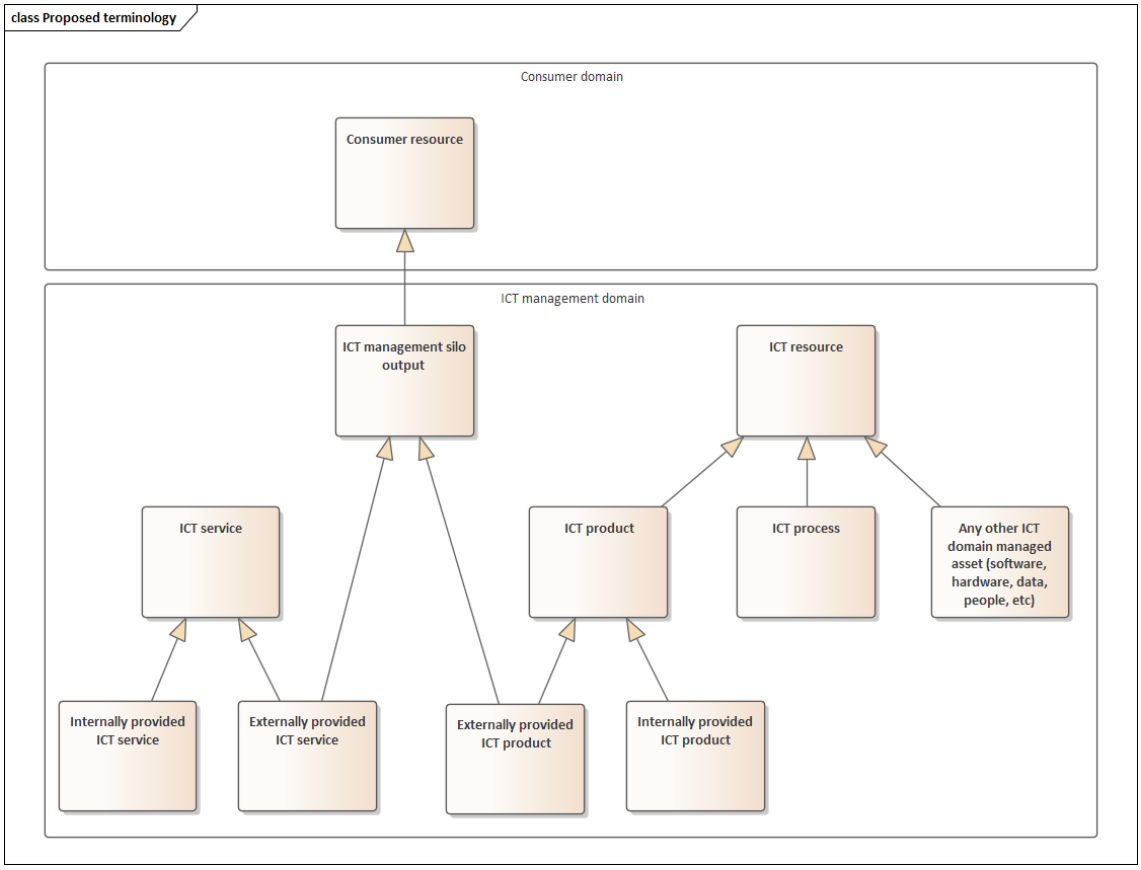

Figure 9. Proposed standardized terminology for unified ICT management portfolios.

This diagram serves as a robust tool for organizing and managing ICT outputs in a hierarchical framework. It enables the standardization of terminology across government silos by providing clear definitions and relationships between managed object sets. In the context of portfolio management, it enables structured oversight, supports cross-silo collaboration, and ensures that ICT portfolios align with business and public service needs.

Following are the definitions and explanations for concepts used in the Figure 9. Proposed standardized terminology for unified ICT management portfolios., which is based on ITIL v4 [17] terminology.

A consumer resource is any resource used by the business or public service domain to perform its operations. ICT management silo outputs are viewed and perceived as part of those resources. From the viewpoint of ICT management domain, consumer resources are the endpoints where ICT management silo outputs are utilized for value delivery. In

addition to ICT management silo outputs, the set of consumer resources contain also other resources that are managed within consumer domain or provided to them from other external domains (for an example consolidated HR or accounting services).

In public services management domain, these resources are used in public service processes and in configurations of products used by those processes. For an example Cyber-Security Training Service can be used in public service management domain as a resource to raise awareness in public servants (improve human resources quality) to raise the quality of public services delivery. Another example would be to use ICT management silo provided product document management software to support organizations document management processes, which support their public services delivery.

The ICT Management Silo Output represents the consolidated view of deliverables produced by ICT management domain. It is a superset containing all the ICT services and products ICT management silo provides externally to other organizations.

This concept behind the terminology aligns with categorization of services in Estonian Handbook for public sector: Strategic Planning and Financial Management [56]. Concept corresponds to the term "external support service", which indicates a service that is servicing other public institutions and is a part of organizations "main services" set, which is the set of organizations outputs. Also, it aligns with the term used in the Estonian regulation "Principles for managing services and governing information" [14] , which sets the base definitions for "service" and its categorization within public sector. It corresponds to the term "support service" halfway, because by definition support service is a service provided to servants or employees from the same or from other public organizations. This means that it includes both - internally provided and externally provided products and services, which contradicts conceptual model proposed by the author and the definition in Strategic Planning and Financial Management Handbook.

An ICT product is a tangible output developed to address specific business or operational needs. An ICT product is configuration of ICT resources to create a value for its consumer. Similarly to services, consumer can be internal or external. Examples include custom software, off-the-shelf applications, or system components, configuration of hardware resources. Providing an ICT product as an output usually means to keep the

product operational and usable for its consumer (fit for use) and keeping it up to date to the business needs (fit for purpose).

An ICT resource is any resource used in the creation, delivery, or maintenance of ICT services and products. This can be human resources, technical resources, data resources or any other. An ICT product or ICT process can also be viewed and considered as an ICT resource. And if ICT products are configuration of ICT resources, then that means that an ICT products can be part of other ICT products. And this can be logically exampled with the example of consolidated infrastructure products. These products are offered as ICT outputs from that ICT management silo and the consumer of that output is another ICT management silo, which treats those outputs as its consumer resources – an ICT resources.

An ICT process represents structured activities or workflows designed to support ICT operations and outputs. These include processes like software development, incident management, and change enablement. Processes can be operational (e.g., deployment) or governance-related (e.g., IT strategy development).

5.2 Selection of portfolios

Kavadias [57] highlights in his book about portfolio management that there are challenges of resource allocation in complex product portfolios, noting that as the number of portfolios grows, the interdependencies between projects lead to increased resource demand and management effort. This means that the more portfolios there are, the more complex becomes the management of these portfolios and their relationships and the management requires growing number of resources.

Author proposes to start small with the standardization and proposes the minimal set of portfolios for ICT management silos based on the predefined standardized sets. As the maturity of standardized portfolio management grows within Estonian ICT silos in the future, more specific and detailed portfolios could be added and interconnected with the existing ones.

Today's terminological approach indicates that both - the outputs of public services business domain units and ICT domain units – are being handled in the same concept, under the concept of "public service" but with different categorization. This means that

unification of managed object portfolios can take place on very high generalization level and all government silo outputs could be included in one portfolio – the portfolio of "services". According to Ashby [58] this kind of over-universalness or tendency to generalization in designing governance frameworks could lead to lower precision or adaptability for particular use cases. For specific organizational needs, outputs of ICT management silos could be perceived as public services and viewed in the same set, but for the day-to-day management of those two should be kept separately. So, from the authors point of view the minimal number of unified portfolios is 2 – one portfolio in business domain, to represent business managed object and one portfolio in ICT domain representing ICT managed objects. In Estonian public sector these two would be public services portfolio and ICT products and services portfolio. The associations between these two portfolio objects should be managed to maintain the ICT management silo outputs alignment with the higher levels of state strategical planning. As Estonian portfolio management capabilities and capacities in public sector mature, more detailed portfolios could be defined and taken into management (like processes or resources) and dependencies between those managed objects could be managed for the purposes of more detailed optimization.

Public services unified portfolio. As the output of Estonian public sector entirety are public services, then it is crucial to have statewide public services portfolio, and the proper portfolio management practices applied in that portfolio that align with the state strategical planning activities. Public service is the central management object where different management silo managed resource pools come together in configuration to provide value to the citizens or community. This is also the central point of strategical alignment, because it is the lowest level of strategical planning system and the highest level of each individual government institution.

Public service is the connector for connecting organizations outputs to strategical planning. But each business domain should consider also, what their management view needs are and create a set of interconnecting portfolios to address those needs. Currently public service business domain organizations have the same kind of output portfolio requirements as for ICT management silos. That means that the output of ICT management silo is connected directly to the public service management object. Although this is enough for some management tasks – like for calculating the costs of a certain public service, then it would be insufficient for some others - like understanding where

does operational inefficiencies of this service lie, or does the received product support service processes in most optimal way, or who is responsible for defining the needs for this ICT product and aligns it with the business strategies?

A portfolios for business domain processes and products should be considered as well. This way an ICT product could be connected straight to business product or processes in order to understand the cost and dependencies of those individual items as well in the business domain. This could be beneficial for understanding the costs of these individual objects or assessing the planned organizational change impact to different processes or connected public services across silos.

ICT products and services unified portfolio. This is a generalization of all ICT management silo defined products and services across the public sector regardless whether they are provided internally or externally. All ICT products and services should be listed and managed in the portfolio throughout their lifecycle from its planning stages to the exit from portfolio. So, the managed objects in the portfolio from the standardized terminology model would be external ICT products and services, representing management silo output and input to consumer resources, but also internal ICT products and services, because from the management viewpoint, these objects can be viewed as homogenous objects. Although services and products are not the same concept, then provisioning of ICT products to its consumers – configuration of processes and all type of resources that support the maintenance, upkeep and development of the product, can be viewed also like an *as-a-service-type* of service – product-as-a-service, which management activities and responsibilities can be very similar, if not the same, to that of the ICT service.

For the purposes of state budgeting and cost management, differentiating each management silo output in the portfolio from internal ICT products and services is required. This way the portfolio can provide required management views according to the needs of the state budgeting and according to the needs of the ICT silo management simultaneously.

For the purposes of the configuration management and its value to the impact assessment in the change management practices, author would recommend considering managing the interconnections between ICT managed assets (resources) and the products. Also,

interconnections between the portfolio items – at least ICT products containing smaller ICT products.

When defining portfolios and portfolio objects, approach for maximum simplification is recommended. Rad and Levin [59] emphasize that overly detailed portfolio definitions can overwhelm management efforts and increase administrative burdens. Simplifying object definitions ensures focus remains on strategic objectives rather than micromanagement. This is further corroborated by Teller et al. [60], who emphasize the need to balance complexity in portfolio definitions to ensure effective resource allocation. They note that excessive detail in object management can lead to operational inefficiencies. This would mean that there is no sense going into too much detail when defining products for the portfolio.

ICT product management usually contains thousands of pieces of codes for different software components, and it is easy to pitfall into defining each one of them. Author would recommend starting with defining ICT products that connect straight with the consumer domain – this means ICT products that are provisioned externally from the ICT management silo. And then define internally provisioned ICT products that are used for operations by more than one externally provisioned ICT products – the reusable components that act as a shared resources for externally provisioned ICT products. For an example, we have two front-end portals that use the same micro-frontend component. Then there is need to register and manage 3 components in the portfolio – two of them are externally provided ICT products and one of them is internally provided product. If that same internally provided micro-frontend component starts supporting some consumer domain object individually also, then the categorization should be changed to externally provided ICT product as well. It would be reasonable to involve ICT management silo technology architect(s) into the ICT product definition process, because they would have the best overview how different components are interconnected and can help the portfolio management to decide, which is the reasonable level of detailness to describe them.

5.3 Standardizing responsibilities

Managing portfolios involves a strategic framework for grouping, prioritizing, and overseeing collections of related objects (like projects, products, services, or assets) to

achieve organizational goals. These management activities span multiple levels, from high-level strategic alignment to tactical and operational execution. Similarly, managing individual portfolio objects requires a lifecycle-based approach to ensure that each object contributes effectively to the portfolio's overall objectives while being optimized throughout its lifecycle. This dual focus—managing the portfolio as a whole and its constituent objects—ensures alignment, efficiency, and scalability.

Standardizing portfolio management activities and portfolio object management activities is crucial for achieving consistency, efficiency, and alignment across complex organizational ecosystems. Such standardization establishes a unified framework that aligns diverse objectives, simplifies processes, and ensures the optimal utilization of resources, which is essential in hierarchical systems with multiple silos. The necessity is well supported by PMI's Standard for Portfolio Management [61] and ITIL v4 [17] frameworks, which emphasize the critical role of consistency in driving strategic outcomes and value creation.

Standardization ensures that portfolio management practices are predictable and uniform, enabling organizations to achieve greater coherence across their operations. As Kaplan and Norton [24] explain, consistency in management practices facilitates the alignment of organizational objectives with actionable goals, allowing entities at various levels to contribute to a unified vision. In ICT management, this coherence ensures that portfolios of products, services, and resources across state, ministry, and organizational levels are not only complementary but also interoperable, reducing redundancies and inefficiencies.

Governance and accountability are also strengthened by standardization. COBIT framework [18] highlights that clarity in roles, responsibilities, and decision-making processes is essential for ensuring that portfolio activities are aligned with organizational priorities and executed transparently. Standardized practices eliminate ambiguities, making it easier to allocate resources effectively and prioritize initiatives that deliver the most value. This alignment ensures that the management of both portfolios and individual objects supports overarching strategic goals while adhering to regulatory and operational constraints.

5.3.1 Management activities

A comprehensive set of management activities should be chosen based on its ability to align organizational objectives, optimize resource use, and ensure consistent value delivery across diverse portfolios. According to Kaplan and Norton [24], management activities should facilitate strategic alignment, translating high-level goals into actionable processes that drive measurable outcomes. Moreover, the activities must address key operational needs, such as governance, resource allocation, risk management, and performance monitoring, as outlined in frameworks like PMI's Standard for Portfolio Management [61] and ISO 21504 [62]. These principles highlight that a comprehensive activity set must also enable adaptability, allowing organizations to respond dynamically to evolving priorities and external changes. By grounding activity selection in proven frameworks, organizations can ensure that their portfolio management practices are not only effective but also scalable and interoperable across different levels.

ITIL v4 is an excellent fit for standardizing ICT projects and product portfolio object management activities because of its holistic, flexible, and value-driven approach. ITIL v4's Service Value System (SVS) ensures that all activities—from strategy formulation to operational execution—are focused on delivering measurable value to stakeholders, a concept emphasized by Axelos [17]. Its modular design allows organizations to adopt practices suited to their size, complexity, and specific needs, as supported by Smith and McKeen [63]. Core ITIL practices like Service Portfolio Management, Change Enablement, and Continual Improvement provide a structured methodology for managing ICT portfolios effectively while promoting alignment with business goals. Additionally, its integration with other standards such as COBIT 2019 and ISO/IEC 20000 ensures ITIL v4 is versatile enough to address both strategic and operational needs in a standardized manner. This combination of adaptability, value focus, and alignment with global best practices makes ITIL v4 a powerful framework for standardizing ICT portfolio management activities.

For portfolio management, the six activity categories—strategic alignment, governance, resource allocation, performance monitoring, risk management, and optimization—are an excellent fit for portfolio management because they provide a comprehensive framework for achieving organizational goals while ensuring efficiency and adaptability. Kaplan and Norton [24] emphasize that strategic alignment ensures all portfolio components

contribute to overarching objectives, while governance establishes accountability and decision-making structures, as supported by COBIT 2019 [18]. Resource allocation optimizes the use of limited resources, balancing priorities, as highlighted by Markowitz's Modern Portfolio Theory [26]. Performance monitoring enables data-driven adjustments and transparency, aligning with PMI's Standard for Portfolio Management [61]. Risk management and optimization ensure resilience and continuous improvement, which are essential for maintaining portfolio relevance in dynamic environments, as noted by Cordella and Paletti [64]. Together, these categories ensure that portfolios are managed effectively across strategic, operational, and tactical dimensions. Detailed list of management activities for each category is described in the Table 4. Division of responsibilities for managing ICT products and services portfolio (PD - Portfolio Director, OO - Object Owner, OM - Object Manager, OP - Object Provisioner).

5.3.2 Roles

Author proposes the division of responsibilities in portfolios into three distinct roles—**Owner, Manager, and Provisioner**—for managing individual objects in an ICT product and services portfolio.

The Owner role is primarily responsible for defining the strategic purpose of the object and ensuring its alignment with organizational goals. This aligns with ITIL v4's Service Portfolio Management Practice, which highlights the need for a role accountable for ensuring that each object delivers value and supports the broader business objectives [17]. The Owner provides the vision and high-level prioritization necessary for integrating the object within the overall portfolio, ensuring that its contribution to strategic outcomes is maximized.

The Manager role focuses on the tactical execution of the object's lifecycle, including planning, monitoring, and optimization. COBIT 2019 emphasizes that operational oversight is essential for managing resources effectively and delivering expected outcomes within constraints [18]. By having a dedicated Manager, organizations can ensure that lifecycle activities such as updates, performance monitoring, and stakeholder communication are handled efficiently without diluting the strategic focus of the Owner.

The Provisioner role is tasked with the operational implementation and technical support of the object. ITIL v4's practices, such as Change Enablement and Deployment

Management, underscore the importance of a technically skilled role responsible for the deployment, maintenance, and day-to-day functioning of ICT objects [17]. The Provisioner ensures that objects are not only functional but also compliant with technical and regulatory standards, reducing risks associated with mismanagement or neglect.

By dividing responsibilities among these three roles, organizations achieve a balanced approach that reduces role conflicts and enhances clarity in accountability. Each role focuses on a specific aspect of the object's lifecycle, ensuring that strategic oversight, tactical management, and technical execution are all addressed without overlap or inefficiency. As highlighted by Kaplan and Norton [24] in their work on the Balanced Scorecard, such role specialization ensures that organizational activities remain aligned with strategic priorities while optimizing operational performance.

In addition to roles managing individual portfolio items the overarching **role of the Portfolio Director** is essential for maintaining strategic alignment, governance, resource optimization, and collective performance across all portfolio items. This role is supported by PMI's Portfolio Management Standard , ITIL v4, COBIT 2019, and ISO 21504, and it ensures that the portfolio as a whole delivers maximum value while enabling individual objects to operate effectively. In environments like public sector ICT management, where portfolios must align with hierarchical goals and support cross-silo operations, the Portfolio Director provides the necessary strategic oversight to unify efforts and achieve organizational objectives.

5.3.3 Roles division in management domains

In Estonian context, in a unified ICT products and services portfolio management structure, roles should be divided between the ICT domain and the consumer domain to ensure strategic alignment, operational efficiency, and accountability. The allocation of roles aligns with their core responsibilities and the distinct contributions of each domain.

The **Object Owner** role should reside in the **consumer domain** because the need for ICT products and services originates from this domain. The Owner is accountable for ensuring that portfolio items (products and services) align with the strategic objectives and operational needs of the consumer organization. By being positioned in the consumer domain, the Owner ensures that the portfolio is demand-driven, and its outputs deliver value to end-users. Kaplan and Norton [24] emphasize that ownership should remain with

stakeholders who define strategic goals and evaluate value outcomes. COBIT 2019 supports this by assigning governance roles to stakeholders who understand the business priorities and expected outcomes for IT-enabled investments [18]. The separation of ownership from ICT management silos reinforces accountability and governance.

The **Object Manager** role should be placed in the ICT domain, as this role focuses on the lifecycle management, operational performance, and optimization of individual ICT products and services. The ICT domain is equipped with the expertise to handle the technical aspects of product and service delivery, including development, configuration, and monitoring. The Object Manager works closely with the Object Owner to ensure that lifecycle activities align with business objectives but operates primarily within the technical and operational sphere. ITIL v4's Service Level Management Practice positions the technical management of services within the ICT domain, ensuring accountability for their performance and delivery [17]. PMI's Standard for Portfolio Management [61] highlights that operational roles focus on managing resources and execution, which are core competencies of ICT management teams.

The **Object Provisioner** role should also reside in the ICT domain, as it focuses on executing technical tasks, such as deploying, maintaining, and supporting ICT products and services. This role ensures the smooth operation of systems and services, adhering to technical standards and addressing day-to-day issues. The Provisioner supports the Manager and collaborates with the Owner to meet the consumer domain's needs but operates firmly within the ICT space. ITIL v4's Deployment Management and Change Enablement Practices emphasize the importance of technical execution roles in maintaining operational continuity and reliability [17].

The **Portfolio Director** role should be a cross-domain role, with responsibilities spanning both the consumer and ICT domains. As the overarching strategic role, the Portfolio Director provides governance, alignment, and prioritization across the portfolio. The Director collaborates with the consumer domain to define strategic objectives and with the ICT domain to ensure effective implementation and resource allocation. PMI's Standard for Portfolio Management [61] highlights the need for a strategic governance role to bridge business and technical domains, ensuring alignment and prioritization. ITIL v4's Service Portfolio Management Practice assigns strategic oversight roles to ensure that service portfolios align with organizational goals and deliver measurable value [17].

5.3.4 Responsibilities of portfolio object management

As the management activities on portfolio level and on portfolio individual object level differ, it would be reasonable to look the division of responsibilities also differently on those levels. Following table describes division of responsibilities for portfolio object management proposed by author.

Table 3. Division of responsibilities for managing ICT products and services portfolio object.

ITIL v4 Management Practice	**Object Owner**	**Object Manager**	**Object Provisioner**
General Management Practices			
Architecture Management	A	R	C
Continual Improvement	A	R	R
Information Security Management	C	A	R
Knowledge Management	A	R	R
Measurement and Reporting	C	A	R
Organizational Change Management	A	R	C
Portfolio Management	A	R	I
Project Management	C	A	R
Risk Management	A	R	C
Service Financial Management	A	R	C
Strategy Management	A	R	I
Supplier Management	C	A	R
Workforce and Talent Management	C	A	I
Service Management Practices			

ITIL v4 Management Practice	**Object Owner**	**Object Manager**	**Object Provisioner**
Availability Management	C	A	R
Business Analysis	A	R	C
Capacity and Performance Management	C	A	R
Change Enablement	C	A	R
Incident Management	I	C	A, R
IT Asset Management	C	A	R
Monitoring and Event Management	I	C	A, R
Problem Management	I	C	A, R
Release Management	C	A	R
Service Catalogue Management	A	R	I
Service Configuration Management	C	A	R
Service Continuity Management	A	R	C
Service Design	A	R	C
Service Desk	I	C	A, R
Service Level Management	A	R	C
Service Request Management	I	C	A, R
Service Validation and Testing	C	A	R
Technical Management Practices			
Deployment Management	C	A	R

ITIL v4 Management Practice	Object Owner	Object Manager	Object Provisioner
Infrastructure and Platform Management	C	A	R
Software Development and Management	C	A	R

5.3.5 Responsibilities of portfolio management

Following table describes division of responsibilities for portfolio management proposed by author.

Table 4. Division of responsibilities for managing ICT products and services portfolio (PD - Portfolio Director, OO - Object Owner, OM - Object Manager, OP - Object Provisioner).

Portfolio management activity	PD	OO	OM	OP
1. Strategic alignment				
Define portfolio strategy and objectives	A	C	I	I
Ensure alignment of objects with organizational goals	A	R	C	I
Identify high-priority strategic initiatives	A	C	R	I
2. Governance				
Establish governance frameworks and standards	A	C	R	I
Ensure compliance with policies and regulations	A	R	R	C
Define roles, responsibilities, and escalation pathways	A	R	C	I
3. Resource allocation				
Allocate resources across portfolio components	A	C	R	I

Portfolio management activity	**PD**	**OO**	**OM**	**OP**
Optimize resource use for individual objects	C	A	R	I
Manage dependencies between portfolio components	A	C	R	I
4. Performance monitoring				
Monitor portfolio-wide KPIs and performance	A	C	R	I
Track and report object-level performance	C	R	A	R
Generate performance reports for stakeholders	A	R	C	I
5. Risk management				
Assess and mitigate portfolio-level risks	A	C	R	I
Identify risks specific to individual objects	C	A	R	C
Implement technical measures to address risks	I	C	R	A
6. Optimization				
Identify improvement opportunities for the portfolio	A	C	R	I
Optimize individual object performance	C	A	R	C
Facilitate lifecycle upgrades and enhancements	C	C	R	A

6 Benefits analysis

Author is basing the benefits analysis with the proposed standardization (in chapter Proposed standardization) on four dimensions of service management described in ITIL v4 [17]. For each four dimension – Organizations and People, Information and Technology, Partners and Suppliers, Value Streams and Processes - a set of benefits are being are brought out and cross-referenced with CAWI research findings and/or literature.

6.1 Organizations and people

Improved role clarity. Clear delineation of roles (e.g., Owner, Manager, Provisioner, Director) reduces confusion and enhances accountability. This addresses current issues within the ICT management silos, across consumer and ICT management domains within the public sector and also issues with clear delegation of responsibilities to the private sector. With the comprehensive set of assigned responsibilities, each role and its expected output becomes clear in the context of every ICT product and service to better serve the goals of the organization. This is supported by Kaplan and Norton [24], who emphasize that well-defined roles streamline alignment with organizational goals.

Enhanced collaboration. Standardized ICT governance fosters teamwork across silos, improving service delivery. When responsibilities are clearly defined and roles assigned, then expectations for individual team members become clearer, which promotes teamwork within the teams. But the clarity of responsibilities also reveals the contribution expectation extent to individual team members, which then can be used for appropriate resource allocation by each cross-collaborative organization. Smith and McKeen [63] also highlight that standardized frameworks enhance cross-functional collaboration. Good example from proposed standardization is that by assigning ICT product or service owner role to consumer domain, it would become clearer to consumer domain leadership, that for getting good products and services from ICT silo that support the best way their processes and value streams, resources have to be allocated (mostly people's time freed) for contributing to the team-work for planning, designing and testing those products and services. Clear governance frameworks reduce conflicts over roles and responsibilities fostering collaboration and according to Rainey [65] minimize intra-organizational friction.

Stronger knowledge management. Unified systems encourage shared knowledge across teams, fostering innovation. People fulfilling certain roles in the model can share experiences on good practices, approaches and how to overcome challenges within their defined responsibility areas. If uniformity in management activities across silos is achieved, and this kind of knowledge sharing is started, then responsibility models can further be improved, cross silo policies reviewed and applied to foster better collaboration for facilitating innovation within products and services. Cordella and Paletti [64] argue that shared knowledge improves efficiency and innovation in public sector ICT.

Improved organizational alignment. ICT governance ensures that IT services are aligned with organizational priorities. With the clear set of roles and responsibilities of each portfolio object, the alignment to organizational priorities can improve even further in the statewide unified portfolios, because it opens wider management views to understand the entirety of goals and priorities across all domains to be able to align properly. Kaplan and Norton [66] stress the importance of alignment between IT initiatives and organizational strategy.

Enhanced capabilities building and culture. By implementing well-defined and standardized practices within and across organizations, the need for peoples' skills also becomes standardized. This helps cultivate a shared mindset across silos, ultimately fostering cultural interoperability by bridging disparate values and communication styles. When ICT teams and business domain stakeholders adopt a common framework like ITIL 4, they not only streamline processes and terminology but also develop a unified sense of purpose that transcends organizational barriers. This collaborative environment reduces friction in decision-making, promotes mutual trust, and encourages knowledge sharing, thereby strengthening each party's capacity to work toward cohesive objectives. As described by Schein [67], a unified culture emerges when consistent processes and shared language guide behaviour. Similarly, Axelos [17] identifies alignment of workflow and communication protocols as fundamental to successful ITIL adoption. In the public sector, where diverse mandates and administrative structures often lead to compartmentalized operations, standardization becomes a catalyst for cultural alignment, forging a collective identity and improving interoperability across management layers [68].

6.2 Information and technology

Enhanced interoperability. Standardized governance ensures ICT systems can seamlessly integrate across silos. Although Estonian public sector has already reached to a good level of cross-silo technical interoperability with X-Road and e-ID infrastructures, then ICT management interoperability across silos is still in its infancy. This presents problems in continuous change processes, especially implementing structural changes into public sector which requires reconfiguration of ICT management silos responsibility areas. ICT products or services leaving from one management silo experience problems integrating into other silos portfolios, because management principles differ. ICT management systems need standardization for further optimization and foster interoperability across management silos as well. Unification of portfolios and its objects management practices would foster the interoperability. Guijarro [69] shows how interoperability frameworks improve collaboration in public sector ICT.

Reduced technical debt. Governance frameworks encourage long-term planning, reducing the accumulation of outdated systems. ISACA [18] argues that structured governance reduces legacy system inefficiencies. With the unified managed objects portfolio, it would be possible to roll out portfolio wide consistent governance policies which defines technical dept and the measures for identifying and prevention. Unified portfolio facilitates the identification and removal of duplicate, obsolete or inefficient products and services and provide the potential for portfolio optimization.

The advancements of technology, especially in the field of software, can be rapid accelerator for growing technical dept in managed systems. Technical dept prevention in software systems is change requirement for ICT products and services that does not stem from consumer domain, but from ICT domain, thus is often left overlooked while planning budgets, because division of state budget is decided on the business side (higher levels). Proposed responsibility model puts the accountability for products budgeting to consumer domain (to product owners), where technical dept should be considered as one of the base components for planned budgets.

Shared ICT infrastructure. Standardized governance encourages resource sharing across silos, reducing redundancy. This would help to streamline current ongoing consolidation of infrastructure services in Estonia and onboarding of RIT clients. Schut

et al. [49] demonstrates the cost-saving benefits of shared ICT infrastructure in standardized portfolio management.

Improved Cybersecurity. Governance ensures consistent application of security protocols, reducing vulnerabilities. Currently many government institutions have been hiring and training information security managers or data protection specialists, who have to work out central policies and instruction for managing organizations data and information systems security and align them with governing regulations (like Estonian Law of Cyber Security, or EU General Data Protection Regulation). With standardized portfolio management practices, these processes and policies have potential to be applied across portfolio in consolidative manner reducing redundant customizations and removing inefficiencies. This reduces the risks raising from differences of each silo capabilities and capacities and creates a favourable ground for information security quality harmonization across all silos. ISO/IEC 27001 [70] emphasizes the role of standardized practices in improving organizational cybersecurity.

Enhanced Disaster Recovery. Unified ICT management activities simplify the creation of standardized recovery processes during disruptions. Good practices can be shared amongst silos and cross portfolio policies and instructions can be described and applied. Continuity management on critical products can be monitored and their effectiveness measured. Through standardized ICT portfolio management practices, diverse ICT management silos unite under a cohesive framework of risk assessment and response strategies. Axelos [17] further emphasizes ITIL's focus on resilience and continuity planning.

6.3 Partners and suppliers

Increased efficiency in public procurements. Standardization approach introduces harmonization, which simplifies tender documentation creation, reducing ambiguity and facilitating comparability among competing bids, leading to cost and time savings for both the agencies and potential suppliers (Thai, 2009). By clearly articulating standardized service metrics and quality benchmarks, procurement officials can more accurately assess bids against a consistent framework, thereby mitigating risk and ensuring the acquired products or services align with the broader IT governance strategy [71]. These standardized guidelines also promote transparency and accountability, as the

decision-making process becomes more traceable and verifiable, reinforcing trust among stakeholders [72]. Ultimately, such uniformity in expectations not only fosters increased efficiency in tendering procedures but also lays a cultural foundation of shared understanding and cooperation, supporting a more sustainable public-sector ICT ecosystem [73].

Joint Procurement Opportunities. Shared procurement strategies reduce costs and improve terms with vendors. Unified ICT products and services portfolio paves the way for joint procurement opportunities across public-sector agencies by consolidating demand and standardizing requirements under a shared governance framework [74]. When multiple organizations leverage the same set of specifications and evaluation metrics, they benefit from collective bargaining power and economies of scale, leading to reduced overall costs and more favourable contract terms with vendors [75]. This coordinated approach also simplifies the tendering process, as vendors can align their solutions to a single set of technical and performance expectations rather than grappling with divergent requirements. From a governance perspective, institutions adopting standardized ITIL-based or COBIT-based portfolios achieve consistent service definitions and performance monitoring, reinforcing transparency and accountability across agencies [18]. The result is a beneficial cycle: shared procurement strategies lower risks, streamline operational overhead, and strengthen inter-agency collaboration, all while improving vendor relationships through clarity of expectations and an expanded market footprint.

Streamlined partners onboarding. By aligning partners and suppliers under a unified governance framework, public-sector organizations establish consistent performance standards that accelerate vendor onboarding and facilitate more cohesive collaboration across public organizations. This shared structure simplifies contract negotiations and operational workflows by relying on a common set of guidelines and key performance indicators, thereby reducing the friction typically associated with integrating new service providers [76]. From a managerial perspective, the use of standardized frameworks also helps ensure a coherent application of metrics that unify technology and business objectives, promoting transparency and accountability [77]. As a result, agencies benefit not just from seamless inter-departmental coordination, but also from the heightened cultural interoperability and strategic agility that a standardized governance model can provide [17].

6.4 Value streams and processes

Support for change management and control. The proposed solution directly enhances impact assessment analysis in change control processes by introducing standardized portfolios, clear role definitions, and interconnected management practices across ICT silos. A unified framework enables organizations to systematically map relationships between managed objects (e.g., services, processes, products, and resources) across silos, ensuring that all dependencies are identified during change assessments. This reduces the likelihood of unforeseen disruptions or inefficiencies during the implementation of changes. Smith and McKeen [63] emphasize the importance of standardized frameworks for ensuring that change assessments are comprehensive and aligned with organizational objectives. Additionally, ITIL v4 highlights change enablement as a critical practice, focusing on systematic impact evaluation and stakeholder involvement to ensure seamless implementation [17]. The CAWI survey highlighted challenges in managing cross-silo dependencies, with respondents frequently citing fragmented governance as a barrier to effective change management. By adopting the proposed solution, organizations can better trace and analyse the cause effects of changes on interconnected systems, processes, and services. For example, modifying a public service workflow in one silo would immediately trigger a structured assessment of its impact on associated ICT systems or data managed by other silos. This has potential to minimizes risks, but also reduce the time and resources needed to evaluate and implement changes.

Improved workflow efficiency. The proposed solution, which focuses on the standardization of ICT management frameworks and the unification of portfolio governance and its principles across silos, offers significant benefits to workflow efficiency within the Estonian public sector ICT ecosystem. By addressing fragmented roles and responsibilities identified through the CAWI survey, the solution fosters clearer task ownership, reduces redundancy, and streamlines decision-making processes, leading to faster project execution. Literature supports that standardized governance frameworks such as COBIT [18] and ITIL [17] improve operational alignment and efficiency by ensuring consistency across domains. This enhanced clarity facilitates smoother interaction with business stakeholders and partners, as a unified structure reduces ambiguity and enhances communication channels. The CAWI results, which highlighted concerns regarding overlapping responsibilities and siloed practices, confirm that a centralized approach would mitigate these inefficiencies and enable more collaborative

cross-domain workflows. As a result, ICT teams can deliver services more effectively, ensuring greater alignment with strategic business goals and improved stakeholder satisfaction.

Optimized resource allocation. The proposed solution drives optimized resource allocation within the Estonian public sector ICT silos. By introducing clear roles and centralized portfolio oversight, resources—whether financial, technological, or human—can be allocated more effectively, eliminating redundancies and maximizing utility. The CAWI survey highlighted inefficiencies caused by fragmented responsibilities and overlapping tasks, which could lead to suboptimal use of resources across silos. Literature supports that portfolio management principles, as established by Markowitz (1952), emphasize optimizing resource distribution to achieve the highest possible return while minimizing risk. Applying these principles to ICT governance ensures resources are allocated based on strategic priorities and actual needs, improving efficiency and accountability. This structured approach not only reduces waste but also enhances collaboration with business stakeholders and partners, enabling the ICT silos to deliver value-driven outcomes without overstretching their capacities.

Harmonized processes across silos. The proposed solution harmonizes ICT management domain portfolios and aligns them with consumer domain portfolios and proposes standardized processes for managed objects management, which reduces disparities in servicing quality. Porter's [78] value chain analysis highlights the benefits of aligning activities across domains to enhance quality and consistency. Also, the benefits of harmonized ICT processes for public sector organizations are discussed by Cordella and Paletti [64]. The CAWI survey further corroborated these findings, revealing disparities in ICT service quality due to fragmented governance practices. By addressing these gaps, harmonized processes enable the delivery of reliable, high-quality ICT services that meet the needs of stakeholders and end-users.

Slowing growth of ICT budgetary needs. The proposed solution could provide benefits that help slow the growth of ICT budgetary needs in the public sector by improving efficiency, optimizing resource use, and reducing duplication of efforts. Fragmented ICT management silos often lead to redundant systems, overlapping projects, and inconsistent resource allocation, all of which inflate operational costs. By harmonizing portfolios and introducing standardized governance frameworks, as supported by COBIT [18] and

TOGAF [53], public sector organizations can eliminate inefficiencies and align ICT investments with strategic priorities. Literature corroborates this idea. For example, Weill and Ross [77] demonstrate that structured ICT governance reduces waste by ensuring that investments are centrally coordinated and aligned with measurable outcomes. Additionally, Lean Management principles [79] emphasize reducing unnecessary processes and resources, which directly curbs costs while enhancing value. The CAWI survey results indicated that there are inefficiencies across silos, such as overlapping responsibilities and fragmented resource allocation, that can likely contribute to increased costs. By addressing these gaps, the proposed solution enables better prioritization of ICT investments, minimizes redundancies in infrastructure and software, and enhances operational transparency. This ensures that existing resources are fully utilized before additional expenditures are considered, ultimately slowing the unsustainable growth of ICT budgetary needs while maintaining or even improving service quality.

Support for cross-silo initiatives. The proposed solution significantly enhances cross-silo initiatives by providing a unified framework for ICT governance, enabling the adoption of standardized platforms and facilitating proactive cross-silo services like life event services. By aligning ICT management portfolios with consumer domain portfolios and establishing shared standards, the solution creates a common language and interoperable processes across silos. This eliminates the barriers caused by fragmented practices, allowing organizations to collaborate effectively on large-scale initiatives that span multiple domains. Guijarro [69] highlights that shared governance frameworks and standardized platforms are critical for fostering cross-organizational collaboration and service integration. Anthopoulos et al. [52] also demonstrates that harmonized processes enable seamless integration of services that address citizens' life events, such as births, marriages, or job changes. The CAWI survey revealed fragmented ICT governance, which could limit cross-silo service innovation and complicates the adoption of shared platforms. By addressing these inefficiencies, the proposed solution fosters an environment where ICT systems and services and their management practices are interoperable, reducing duplication and enabling proactive, user-centric services. For instance, life event services that require data and workflows from multiple agencies—such as registering a birth, applying for benefits, and updating residency information—can be delivered seamlessly when silos operate under a unified framework. This not only

improves service delivery but also positions the public sector as a leader in citizen-focused innovation.

6.5 Summary of benefits analysis

The benefits analysis suggests that implementing standardized portfolio management practices in Estonian ICT governance has the potential to deliver significant improvements across various dimensions of service management, provided the solution is effectively implemented. The proposed approach, which aligns roles, responsibilities, and processes across silos, offers the opportunity to address inefficiencies by enhancing role clarity, fostering collaboration, and encouraging knowledge sharing. This could lead to improved organizational alignment and cultural cohesion, but these outcomes depend on the successful adoption and execution of the framework.

There is also potential for better resource optimization, as the standardization could enable more effective allocation of financial, technological, and human resources while minimizing redundancies. Harmonized processes across silos might reduce disparities in service quality, streamline workflows, and facilitate cross-silo initiatives like life event services, as indicated by findings from the CAWI survey. However, achieving these benefits requires consistent effort and commitment to applying the framework across diverse domains.

Additionally, the proposed solution could help slow the growth of ICT budgetary needs by improving interoperability, reducing technical debt, and encouraging shared infrastructure usage. Furthermore, it could enhance disaster recovery, cybersecurity, and procurement practices, contributing to greater resilience and transparency. Nevertheless, realizing these benefits relies heavily on proper implementation and ongoing adherence to the principles of standardized governance.

In conclusion, while the potential benefits of standardized portfolio management in Estonian ICT governance are substantial, their realization is contingent on effective implementation and sustained application. The framework presents a valuable opportunity to address current inefficiencies and drive long-term innovation, but its success will depend on the ability to align efforts across stakeholders and consistently apply the proposed standards.

7 Summary

This thesis has explored the challenges and opportunities inherent in standardizing ICT governance within the Estonian public sector, providing a structured analysis and proposing actionable solutions to address persistent inefficiencies. The research identified possible critical gaps in role clarity, resource allocation, and interoperability across ICT management silos, issues exacerbated by fragmented governance practices and the absence of standardized portfolio management frameworks. The CAWI survey results revealed that these inefficiencies can significantly hinder the alignment of ICT operations with organizational priorities, creating disparities in service quality and resource utilization. By proposing a unified governance model, this thesis aims to address these challenges while fostering collaboration, improving workflow efficiency, and enabling cross-silo initiatives that enhance public service delivery.

A key insight from this study is the necessity of aligning ICT governance with consumer domain portfolios, such as public services and organizational processes. This alignment could significantly improve not only the internal management of ICT operations but also the quality of services delivered to end-users. The findings suggest that standardization could mitigate redundancies, optimize resource use, and harmonize processes across silos. However, the realization of these benefits depends on the effective implementation of the proposed framework and the active participation of all stakeholders involved in ICT governance.

The implications of this research extend beyond operational improvements. Standardized governance practices offer the potential to slow the growth of ICT budgetary needs in Estonia, enhance cybersecurity protocols, and create a foundation for seamless cross-silo service delivery, such as life event services. These advancements position the Estonian public sector as a leader in digital innovation, capable of delivering citizen-centric solutions with greater transparency and accountability.

Despite its contributions, this thesis leaves several areas open for future research. One critical area is the exploration of terminological differences across governance

frameworks and their impact on organizational management and operations. Terminological misalignments can create misunderstandings, misaligned expectations, and operational inefficiencies, particularly in cross-organizational contexts. Investigating how a unified lexicon could bridge these gaps would provide valuable insights for both academic research and practical governance applications.

Additionally, further studies could evaluate the long-term impacts of standardized governance practices on organizational culture, particularly in terms of fostering collaboration and cultural alignment across silos. As the research focuses on the positives, also negative impacts should be researched. Another promising area of inquiry lies in examining the scalability of the proposed solutions, particularly for smaller public sector organizations with limited resources. Such research would not only refine the proposed model but also provide practical guidance for its implementation across diverse organizational contexts.

In conclusion, this thesis highlights the pressing need for standardized ICT governance in Estonia and offers a roadmap for its implementation. While the proposed solutions address many of the identified inefficiencies, their success hinges on sustained commitment, cross-sector collaboration, and adaptability to emerging challenges. By building on the findings presented here, future research can deepen our understanding of ICT governance and contribute to the development of more resilient, efficient, and innovative public sector systems.

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Appendix 2 – Survey questionnaire

Following is the survey questionnaire that was used for the survey. Original questionnaire was in Estonian, it is translated for this thesis purposes. Each horizontal divider represents one section of the information that was displayed for the respondent at the time of responding. Each section was

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Survey Instrument: Responsibility Distribution in ICT Development

(Conducted as part of the Ministry of Finance procurement project.)

Introduction

This survey collects current practices of responsibility distribution in ICT developments across ministries and their subordinate institutions. The survey does not require specialized ICT knowledge and takes approximately 15 minutes to complete. Participation is anonymous.

Section 1: Your Profile

1. **What is your role in ICT developments?** *(If you represent the business side or beneficiary, select "I am in the client's role." If you represent the ICT side, select "I am in the provisioner's role.") (select one)*

- ☐ I am in the client's role.
- ☐ I am in the provisioner's role.

2. **Which organization/institution do you work for?** *(Please provide the full name of your organization.)(Open-ended response field, max 24 characters)*

3. **Would you like to provide additional details about your profile?** *(Optional open-ended response field, max 40 characters)*

Section 2: Management Practices

1. **Which management practices are applied in your organization for ICT developments?** *(Definitions of terms like Business Process Management, Product Management, and Portfolio Management are provided.) (Select one or more.)*

- ☐ Business Process Management *(Value: Y)*
- ☐ Product Management *(Value: Y)*
- ☐ Service Management *(Value: Y)*
- ☐ Business Architecture Management *(Value: Y)*
- ☐ Portfolio Management *(Value: Y)*

2. **Which frameworks or principles are used for process and IT governance, management, development, and maintenance?** *(Select one or more.)*

- ☐ Agile (Value: Y)
- ☐ BABOK (Value: Y)
- ☐ BIZBOK (Value: Y)
- ☐ BPM (Value: Y)
- ☐ COBIT (Value: Y)
- ☐ DevOps (Value: Y)
- ☐ DevSecOps (Value: Y)
- ☐ ITIL (Value: Y)
- ☐ Kanban (Value: Y)
- ☐ Lean (Value: Y)
- ☐ SAFe (Value: Y)
- ☐ Scrum (Value: Y)
- ☐ TOGAF (Value: Y)
- ☐ VeriSM (Value: Y)
- ☐ Security-by-Design (Value: Y)
- ☐ Continuous Delivery/Continuous Integration (CD/CI) (Value: Y)
- ☐ Low-code/No-code (Value: Y)
- ☐ Others (Value: Y) (Optional field: Open-ended response, max 24 characters.)

Section 3: Process Management

1. **How are responsibilities for process management defined in your organization?** *(Choose the applicable options for each sub-question.)*

- Process definition (architecture):
    - ☐ Business side
    - ☐ IT side
    - ☐ Both business and IT sides *(Value: AO05)*
    - ☐ Undefined
- Process mapping and modeling (as-is views): *(Same options as above)*
- Process improvement assessment: *(Same options as above)*
- New process design (to-be views): *(Same options as above)*
- Coordination of process implementation: *(Same options as above)*
- Measuring process performance: *(Same options as above)*
- Initiating and managing process changes: *(Same options as above)*

2. **Would you like to add comments about your responses?** *(Optional open-ended response field, max 40 characters)*

Section 4: Product Management

1. **How are responsibilities for product management defined in your organization? Where does the following occur?** *(Choose the applicable options for each sub-question.)*

- Definition and communication of product vision/strategy:
    - ☐ Business side
    - ☐ IT side
    - ☐ Both business and IT sides
    - ☐ Undefined
- Securing funding for product development: *(Same options as above)*
- Ordering developments for the product: *(Same options as above)*
- Proper product design: *(Same options as above)*

- Defining and communicating backlog development needs: *(Same options as above)*
- Prioritization of product developments: *(Same options as above)*
- Product implementation, technical testing, and delivery: *(Same options as above)*
- Business requirement compliance testing: *(Same options as above)*
- Managing scope vs budget vs timeline of projects: *(Same options as above)*
- Managing work for product development projects: *(Same options as above)*
- Consulting and training product users: *(Same options as above)*

2. **Would you like to add comments about your responses?** *(Optional open-ended response field, max 40 characters)*

Section 5: Service Management

1. **How are responsibilities for service management defined in your organization? Where does the following occur?** *(Choose the applicable options for each sub-question.)*

- Client relationship management:
    - ☐ Business side
    - ☐ IT side
    - ☐ Both business and IT sides
    - ☐ Undefined
- Approval of the service provision budget: *(Same options as above)*
- Approval of service changes: *(Same options as above)*
- Definition of service requirements: *(Same options as above)*
- Measuring service performance: *(Same options as above)*
- Provision of services to beneficiaries: *(Same options as above)*

2. **Would you like to add comments about your responses?** *(Optional open-ended response field, max 40 characters)*

Section 6: Business Architecture Management

1. **How are responsibilities for business architecture management defined in your organization? Where does the following occur?** *(Choose the applicable options for each sub-question.)*

- Management of business architecture:
    - ☐ Business side
    - ☐ IT side
    - ☐ Both business and IT sides
    - ☐ Undefined
- Management of information architecture: *(Same options as above)*
- Management of service architecture: *(Same options as above)*
- Management of process architecture: *(Same options as above)*
- Management of data architecture: *(Same options as above)*
- Management of technical architecture: *(Same options as above)*
- Management of application architecture: *(Same options as above)*

2. **Would you like to add comments about your responses?** *(Optional open-ended response field, max 40 characters)*

Section 7: Portfolio Management

1. **How are responsibilities for portfolio management defined in your organization? Where does the following occur?** *(Choose the applicable options for each sub-question.)*

- Management of the services portfolio:
    - ☐ Business side
    - ☐ IT side
    - ☐ Both business and IT sides
    - ☐ Undefined
- Management of the process's portfolio: *(Same options as above)*
- Management of the products portfolio: *(Same options as above)*
- Management of the projects portfolio: *(Same options as above)*

2. **Would you like to add comments about your responses?** *(Optional open-ended response field, max 40 characters)*

Section 8: Feedback

1. **Rate the following statements about the survey and your organization:** *(Select one)*

- I have a clear understanding of responsibilities in ICT developments in my organization.
    - ☐ Strongly Disagree
    - ☐ Disagree
    - ☐ Agree
    - ☐ Strongly Agree
- Responsibilities for ICT development are easily identifiable in my organization. *(Same options as above)*
- The terms used in this survey are easy to understand. *(Same options as above)*

2. **Would you like to add comments about your responses?** *(Optional open-ended response field, max 40 characters)*

Closing Note

Thank you for your time and effort. Your responses have been successfully submitted. For further questions, please contact:

- Technical issues: Janar Linros (CheckIT OÜ) – janar.linros@checkit.ee
- Project inquiries: Merle Küngas (Ministry of Finance) – merle.kyngas@fin.ee